APPENDIX A

A Model for Assessing the Effects of Altered River Flows on the Recruitment of Riparian Cottonwoods

John M. Mahoney and Stewart B. Rood

Introduction

Riparian cottonwoods (poplars) have declined along many rivers in western North America (Johnson and Haight 1984; Rood and Mahoney 1990; Sands and Howe 1977). The effects of livestock grazing or clearing for agricultural use or domestic settlement have reduced cottonwood abundance directly. Other factors, such as alteration of the hydrological regime, have had an indirect effect on cottonwood abundance (Stromberg et al. 1991). The indirect factors can prevent cottonwood forest replenishment by affecting conditions that are essential for the recruitment of cottonwood seedlings (reviewed in: Rood and Mahoney 1990).

River valley cottonwoods are phreatophytic and obtain moisture from the riparian water table. This saturated zone extends more or less horizontally from the river and fluctuates with the river stage. Cottonwoods are adapted to natural variations in water table level caused by seasonal fluctuations in river flow.

Figure 1 presents a general hydrograph for a western foothills river showing five hydrological elements that are essential for cottonwood seedling establishment and initial survival. Elimination of any of these elements will result in the failure of seedling establishment. Minor changes to only one element may not have a deleterious effect on cottonwood seedlings, but if two or more elements are altered, the cumulative effect may become substantial.

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The 'Recruitment Box'

The following model considers the basic hydrological elements that are necessary for the establishment of riparian cottonwood seedlings. Attention is given to seedling recruitment because it is likely to be a particularly vulnerable component of the cottonwood forest cycle. The model does not consider the effects of precipitation, temperature, or other factors that can affect the the success of developing seedlings; nor does the model address the conditions necessary for the maintenance of established cottonwoods.

The hydrological conditions essential for cottonwood seedling success can be defined by river stage and time of year (Figure 2). The river stage identifies a zone along the river bank where cottonwood seedlings can survive. Seedlings that establish above an upper elevation limit will not be able to maintain adequate root growth to tap the deep

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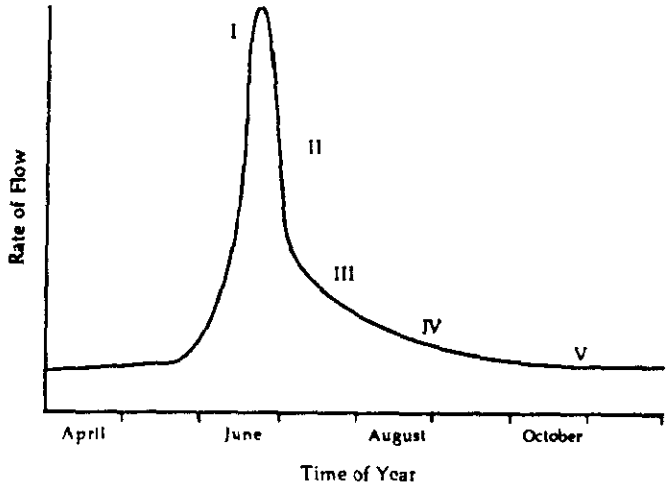

Figure 1. A generalized hydrograph for a river in the foothills of Alberta. The hydrological factors important for cottonwood seedling establishment are:

1. Peak flows to prepare germination sites,
2. Receding flows at time of seed release to expose new germination sites,
3. Gradually declining water table to limit seedling drought stress and prompte root growth,
4. Adequate summer flows to meet high water demands, and
5. Adequate autumn flow to improve plant water balance and over-winter survival

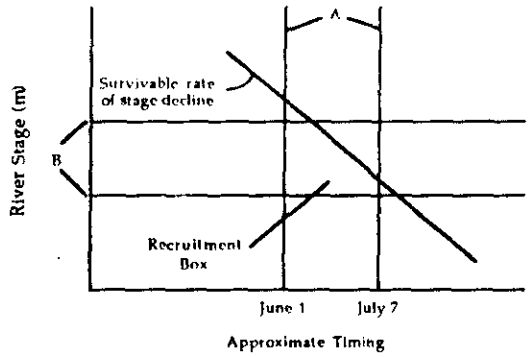

Figure 2. Model framework including the maximum survivable rate of water table decline for cottonwood seedlings in southern Alberta. The annual opportunity for successful seedling recruitment is limited to the 'Recruitment Box'. "A" indicates the period of seed release and viability. "B" indicates the approximate bank elevation for successful seedling establishment.

water table at the end of the growing season. These seedlings will suffer from drought stress and die. A lower bank elevation limit can also be identified for seedling survival. Seedlings that establish below this elevation are likely to be scoured away by ice or flooding, or may be covered with fresh sediment the following year. These upper and lower elevation limits result in the formation of characteristic bands of cottonwoods along river banks of the foothills and western prairies (Bradley and Smith 1986).

A critical period for cottonwood seedling establishment occurs annually. This seedling establishment period starts with the onset of seed release and continues through the period of seed release, typically a four to six week period. The seedling establishment period ends about one week after seed release is complete, when the small cottonwood seeds lose their viability. Inadequate moisture conditions during this period will result in the failure of seedling establishment for that year.

The limits set by upper and lower bank elevations and the availability of viable seeds define an annual opportunity for cottonwood seedling establishment. This opportunity is represented as the 'Recruitment Box' in Figures 2 through 4.

Water Table Decline

A third hydrological component that determines initial seedling survival is the rate of water table decline. The water table must drop gradually enough to allow cottonwood seedlings to maintain root contact with the receding water supply. Greenhouse experiments confirm field studies that indicate that drought stress and drought-induced mortality of seedlings accompanies abrupt rates of water table decline (Mahoney and Rood 1991). A water table decline of 4 cm per day has been found to be the maximum survivable by some cottonwood seedlings (Mahoney and Rood 1991). However, the survivable rate of water table decline varies with cottonwood species and is influenced by the texture of the riparian substrate (Mahoney and Rood 1992).

Figure 3 illustrates hydrological conditions that are potentially ideal for cottonwood seedling establishment. A peak flow precedes seed release to prepare new seed beds. Initial stage decline is fairly rapid, exposing large areas that are moist and barren. The stage decline in the latter part of the critical period is slow enough that roots of the new seedlings are able to maintain contact with the receding water table.

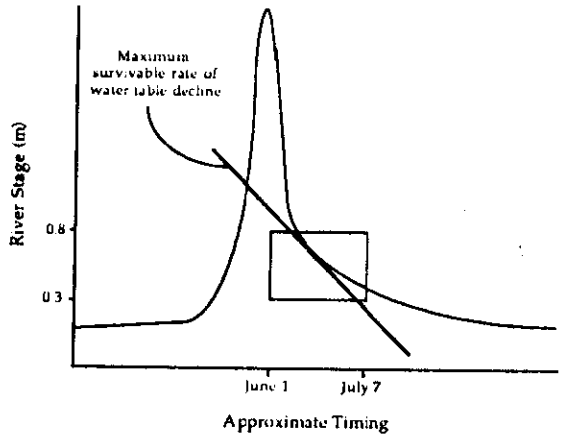

Figure 3. The relationship between a generalized hydrograph for southern Alberta and the 'Recruitment Box' including the survivable rate of water table decline for cottonwood seedlings.

Application of the Model

Seedling Recruitment

This model may explain why cottonwood establishment is not successful every year under natural conditions. Although the elements that define the Recruitment Box are relatively constant, hydrological patterns vary from year to year. If peak flows occur early in the season, flows may taper to low levels before seed release so that seedlings only germinate at low bank elevations. These seedlings are likely to be covered with sediment or scoured away the following spring. In years where peak flows are late, seeds germinating prior to peak flows will be washed away by higher flows that same year. Seedlings that establish following the peak flow will be at bank elevations too high for root growth to the late summer water table. These seedlings will suffer drought stress and die during the first summer. Field studies in southern Alberta indicate that although numerous cottonwood seeds germinate annually, very few survive the initial summer (Virginillo et al. 1991). The poor survival of

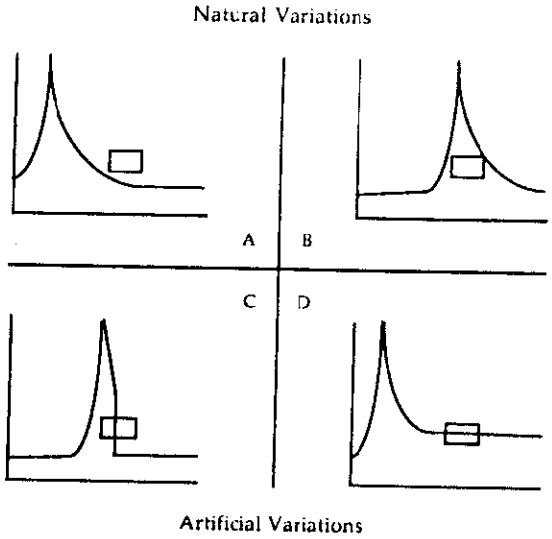

Figure 4. Variations in river flows and their relation to the 'Recruitment Box'.
A. Peak flow receding to minimum levels before the onset of seed release,
B. Peak flow receding to minimum levels after seed germinability has ended,
C. Abrupt reduction of river flows during the period of seed germinability,
D. Constant flow regulation during the period of seed germinability.

seedlings suggests that natural flow patterns are seldom suitable for cottonwood seedling survival in southern Alberta and that new trees may only establish at five or ten year intervals.

Artificial Flow Regimes

The effects of managed river flow patterns on cottonwood seedling establishment may also be predicted with this model. Figure 4c (not included in this paper) illustrates a situation where a dam is closed shortly after peak flow causing an abrupt decline in downstream flows (Rood and Heinze-Milne 1988). In this case the rate of water table decline is too great for the roots to maintain contact with the water supply. Seedlings that germinate under these conditions will suffer drought stress and die.

Constant flow conditions may not affect seedling survival during the first year and may be favorable to existing trees. However, the new seedlings would develop a shallow root system making the them vulnerable to subsequent scouring or flooding. A gradually declining water table is preferable as it encourages deep root development in new seedlings (Mahoney and Rood, 1991). Stabilized flows also permit encroachment of grasses and other vegetation to the river's edge, further limiting the formation of new barren zones essential for cottonwood seedling establishment.

The values applied to each parameter defining the Recruitment Box will vary with the reach of the river being investigated and the regional cottonwood phenology. For rivers in the foothills of southern Alberta, seed release normally occurs from late May to early July. The bank elevation for seedling establishment is about 0.3 m to 0.8 m above natural minimum summer flows with some variation likely between rivers. Experimentation in the greenhouse has shown that natural poplar hybrids can survive a maximal rate of water table decline of about 4 cm day-1 in a gravel/sand substrate typical of southern Alberta floodplains.

Conclusion

The preceding model provides a framework for assessing the effects of existing or proposed flow regimes on seedling recruitment of riparian cottonwoods. Recorded or projected flow patterns for a particular river reach can be evaluated for the critical period of seed release to determine whether river stages and rate of decline fall within the range necessary for seedling establishment. In managed river systems, identification of the hydrological elements that fail to meet these ranges may allow river managers to adjust flow patterns to improve the prospects for the replenishment of riparian cottonwood forests.

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APPENDIX B

Representative Projects

Merced River Corridor Restoration Plan
Client: Merced County Planning and Community Development Department

The sediment supply, hydrologic regime, and floodplain and channel morphology of the lower Merced River have been significantly altered by dams and in-channel and floodplain mining, resulting in loss and degradation of habitat for native species, particularly chinook salmon. Despite general recognition of the degraded condition of the Merced River, no long-term restoration strategy has been developed for the Merced River corridor. With funding from CALFED and the U.S. Fish and Wildlife Service Anadromous Fish Restoration Program, this project will develop a long-term, large-scale restoration and monitoring program that will identify and restore critical geomorphic and ecological processes for the Merced River from Crocker-Huffman Dam downstream to the confluence with the San Joaquin River. Such a strategy will ensure the continuing long-term effectiveness of site-specific restoration projects and provide long-term benefits to ecosystem processes, riverine habitats, and native species. The project is being implemented in two phases: (I) establishing a Merced River Stakeholder Group and Technical Advisory Committee (TAC), (II) analyzing and quantifying current in-channel, riparian, and floodplain conditions and processes. The third phase (not yet funded) will synthesize input from the Stakeholder Group and TAC (Phase I) and results of the geomorphic and ecological baseline evaluations (Phase II) to develop a Merced River corridor restoration and monitoring plan.

Salmon Habitat Enhancement and Watershed Planning on the Tuolumne River
Client: Turlock and Modesto Irrigation Districts

Stillwater Sciences staff designed and supervised a research program on the ecology of chinook salmon in the Tuolumne River below New Don Pedro Dam, and developed a cost-effective salmon enhancement program. The project has included modeling, field research, field testing of management strategies, and reviewing research conducted under the FERC licensing process. Stillwater Sciences' ongoing work includes developing an index of spawning gravel quality for chinook salmon based on *in situ* measurements of substrate permeability, systematically assessing fry and juvenile stranding occurring under recently revised flow requirements and ramping rates, and implementing a pilot-level experiment using innovative marking and analytical methods to quantify smolt survival during outmigration in specific reaches of the Tuolumne River and the relationship of survival to flow magnitude.

In addition, Stillwater Sciences has provided support to the Districts to ensure regulatory compliance with the National Environmental Policy Act and the California Environmental Quality Act for construction of large-scale restoration projects in the Tuolumne River and has developed strategies for the Districts to address the proposed listing of the Central valley fall/late fall-run chinook salmon ESU under the Endangered Species Act.

North Umpqua River Cooperative Watershed Analysis
Client: PacifiCorp

The North Umpqua Hydroelectric Project encompasses eight hydroelectric developments owned by PacifiCorp, which is seeking a new license from the Federal Energy Regulatory Commission to operate the project. Stillwater Sciences has conducted a watershed analysis using available and newly collected data to resolve scientific issues regarding aquatic and terrestrial ecosystems and the impacts of the hydroelectric project and other land use disturbances on these systems. Stillwater Sciences has led interagency scientific subgroups through a collaborative scientific process, and is participating in settlement negotiations involving policy-makers from state and federal agencies and environmental groups. The firm has developed management alternatives that provide for hydroelectric power generation while addressing natural resource concerns, including management strategies for four species of anadromous salmonids (coastal cutthroat trout, coho salmon, spring-run chinook salmon, and summer- and winter-run steelhead), three species of trout (rainbow, brown, and brook), selected amphibians (e.g., red-legged frog), and terrestrial wildlife.

An important component of the North Umpqua Cooperative Watershed Analysis has been the evaluation of management options to maintain and/or restore populations of native anadromous fish species. In particular, Stillwater Sciences has assessed the potential effects on anadromous fish species of providing fish passage at two project dams that currently block fish migrations in the North Umpqua River basin and has evaluated fish passage options in comparison to off-site mitigation strategies. This analysis has been based in part on the use of a reference model describing current and historical physical habitat conditions and carrying capacities for anadromous salmonids to estimate potential smolt production under different management scenarios. Management strategies for anadromous fish have also been evaluated in the context of the Endangered Species Act; the Umpqua coastal cutthroat trout is currently listed as endangered under the ESA.

The North Umpqua Cooperative Watershed Analysis project was explicitly designed to advance the science of watershed analysis. The Stillwater Sciences team includes many of the scientists who were involved in the development of the original Washington DNR watershed analysis methodology, including Kate Sullivan and Jeff Light of Weyerhaeuser Corporation, Dave Montgomery and John Buffington of the University of Washington, and William Dietrich and Mary Power of the University of California at Berkeley. The team has developed a more quantitative, more predictive, and semi-automated (using DTM and GIS) watershed assessment process and expanded the scope of watershed analysis to include the geomorphic and ecological effects of dams, waterways, and related hydroelectric facilities.

South Fork Eel River TMDL Support
Client: U.S. Environmental Protection Agency

The South Fork Eel River has been listed by EPA as an "impaired waterbody" because beneficial uses, including salmonid habitat, have been adversely affected by sediment and temperature. Stillwater Sciences, through Tetra Tech Inc. (the prime contractor) is using a regional watershed analysis approach to develop the technical information that will provide EPA with a basis for setting "Total Maximum Daily Load (TMDL) allocations for the 690 mi^2 river basin. The main elements of Stillwater's work include: 1)

Developing Numeric Targets for Sediment. These are based on indicators of habitat quality for spawning, summer rearing and winter rearing. A channel classification system that utilizes a digital terrain model (DTM) will help identify the channel types and their main habitat constraints. 2) *Analysis of Sediment Sources.* This is based on a rapid sediment budget that utilizes a GIS/DTM to stratify the watershed, coupled with intensive field investigation of sediment sources in selected subbasins. 3) *Temperature Assessment and Modeling.* This is based on analysis of a temperature data set from about 75 recording thermographs, together with a heat loading model that makes use of DTM and LANDSAT imagery to calculate riparian and topographic shading, low-flow discharge and channel width. The model is field-calibrated and verified using measurements of canopy shading and measurements relating low-flow discharge to hydraulic geometry.

Integrated Riparian Management Study for Headwater Streams
Client: NCASI (National Council of the Paper Industry for Air and Stream Improvement, Inc.)

Regulatory approaches to the management of riparian areas in the western United States generally recognize that headwater streams provide different ecological functions and values than do larger fish-bearing streams. The regulation of timber harvesting activities in the vicinity of headwater streams, however, is often based on little more than guesswork. This project seeks to improve the scientific basis for headwater riparian area management to protect ecosystem functions and native species. The first phase of this project includes: (1) the development of a conceptual model of headwater stream and riparian ecosystems, focusing on the importance of these areas to amphibian and macroinvertebrate populations; (2) field surveys to test hypotheses about the influence of key habitat and landscape features on the distribution and abundance of amphibians (e.g., tailed frogs and torrent salamanders) and macroinvertebrates; and (3) manipulative experiments of instream habitat characteristics to provide more critical tests of key hypotheses about habitat requirements of headwater stream amphibians and invertebrates. Phase II of this project will explore the effects of forest management on the key habitat features identified during Phase I, including interactions at the watershed or landscape scale, to help in the development of integrated riparian management strategies.

Endangered Species Act Compliance
Client: Portland General Electric

Portland General Electric (PGE) operates several hydropower projects in western Oregon on the Deschutes, Sandy, Clackamas, and Willamette rivers. The projects are located within the ranges of several salmonid species which have been listed or are proposed for listing under the Endangered Species Act (ESA) or are currently undergoing status review. Protection of these species under the Endangered Species Act requires coordination between PGE and the National Marine Fisheries Service (NMFS) for current operations and future Federal Energy Regulatory Commission (FERC) relicensing. Stillwater Sciences is preparing biological assessments for the endangered salmonids that may be affected by PGE's projects, and working with the company and the relevant federal agencies to ensure PGE's compliance with the ESA.

APPENDIX C

Douglas Allen

Geographic Information Systems Specialist and Geomorphologist

Mr. Allen has over 8 years of experience in physical geography, with an emphasis on hillslope and fluvial geomorphology, digital terrain modeling, remote sensing, and GIS. Mr. Allen is currently working with Dr. William Dietrich and Stillwater Sciences as a GIS specialist and geomorphologist to develop state-of-the-art techniques for watershed analysis.

Education

Ph.D. Candidate, Physical Geography, University of California at Berkeley, 1996
Graduate work in Water Resources and Hydrology, University of Arizona, Tucson, 1990
B.S., Physical Geography, University of Leeds, 1987

Professional Experience

Watershed Analysis

Mr. Allen is currently working on several watershed analysis projects. During the past year, he has conducted digital terrain modeling and GIS analysis tasks for the Louisiana-Pacific SYP/HCP and the North Umpqua Watershed Analysis projects, including generation of shallow landslide hazard potential, channel network, channel gradient, CDF watercourse classification, and substrate particle size coverages. He is also involved in field studies regarding hillslope and fluvial geomorphology for these projects.

Geographic Information Systems

Mr. Allen has been working with Dr. William Dietrich's geomorphological modeling research laboratory in the Department of Geology and Geophysics at UC Berkeley. Projects included digital terrain modeling, digital watershed analysis, GIS modeling and analysis of fluvial environments. He has also worked with Dr. John Radke in the Applied Environmental GIS Laboratory in the College of Environmental Design at UC Berkeley. Projects included the East Bay hills emergency fire response project; the Klamath GIS project; Oakland, Orinda/Moraga Hills digital terrain modeling; and the City of Richmond toxic flume analysis.

Geomorphology/ Soils/Hydrology

Mr. Allen has worked on several projects for the Overseas Development Natural Resources Institute (UK). In Belize, he worked with the Soil Survey of Corozal District, conducting field surveys, augering, and soil profile sampling of 6- to 8-foot soil pits. Analyzed remotely sensed information with reference to soil catenas. He also conducted hydrological surveys of the Cayo District in Belize, assessing the agricultural potential of land resources. Tasks included field sampling and measurement of soil hydrological parameters, bathymetric surveys of selected rivers, and meteorological data collection and analysis. At the Shipstern Lagoon Wildlife Reserve in Belize, Mr. Allen performed soil surveying and water quality analyses of a newly established wildlife reserve, for the purposes of designing a management plan for the reserve.

Computer Skills

Mr. Allen is proficient with UNIX, DOS, and Macintosh operating environments; C-programming language; geographic information systems (ARC/INFO, GRASS); CAD (Integraph Microstation); and various statistical packages.

Peter Fritz Baker, Ph.D.

Mathematical Biologist

Dr. Baker has nine years of experience in applications of mathematics and statistics to fisheries biology. His primary experience is with chinook salmon populations of Central California.

Education

Ph.D., Mathematics, University of California at Berkeley, 1987
B.S., Mathematics, University of Kansas (*summa cum laude*, honors in mathematics), 1981

Professional Experience

Mathematical Biology and Statistics

Dr. Baker has prepared or assisted in the preparation of numerous reports on the chinook salmon of the Tuolumne River of California, and on the survival of chinook salmon in the Sacramento-San Joaquin River Delta of California. He is the principal author of a paper on the relationship between water temperature and salmon smolt survival.

Simulation Modeling

Dr. Baker has been responsible for maintenance and continued development of the EACH simulation model for San Joaquin chinook salmon populations since 1989, and has developed or assisted in the development of numerous other models for populations of salmonid fishes in California and Montana. He has developed individual-based models of spawning habitat usage by salmonid fishes. He has extended PHABSIM modeling of chinook salmon habitat in the Tuolumne River to include water temperature considerations.

Professional Affiliations

Bay-Delta Modeling Forum
American Mathematical Society
Mathematical Association of America
Association for Symbolic Logic

Selected Publications and Presentations

Baker, P.F. 1997. The influence of temperature on the survival of chinook salmon smolts (*Oncorhynchus tshawytscha*) migrating through the Sacramento – San Joaquin River of California. Presented at the Bay-Delta Modeling Forum Workshop on Statistical Analysis of Coded-Wire-Tag Data, Sacramento, California, December 4, 1997.

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article

Yantao Cui, PhD
Civil Engineer

Education

Ph.D., Department of Civil Engineering, University of Minnesota. 1996.
M.E., Department of Hydraulics, Institute of Water Conservancy and Hydro-Electric Power Research (IWHR), Beijing, China, 1987.
B.E., Department of Hydraulic Engineering, Tsinghua University, Beijing, China, 1984.

Professional Experience

Recent Research Topics

- Modeling of river response to landslide and debris flow
- Modeling of reservoir removal
- Modeling of effects of woody debris jams on sediment transport
- Numerical modeling of river response to gravel extraction and addition
- Numerical modeling of grain sorting
- Study of sedimentation in response to mine waste disposal
- Modeling of river bank erosion
- Evaluation of countermeasures for bridge scour
- Study of tailings basin performance
- Design of hydraulic structures

Recent Applied Engineering Projects

- Modeling of countermeasures for river degradation in the Little Wekiva River, Orlando, Florida
- Modeling of aggradation, flooding, and floodplain deposition due to mine-derived sediment in the Ok Tedi River, Papua New Guinea
- Modeling of aggradation, flooding, and floodplain deposition due to mine-derived sediment in the Ok Tedi—Fly River system, Papua New Guinea.
- Modeling of river response to sediment input due to human activities in the Pacific Northwest of the USA.

Professional Affliliations

American Geophysical Union
International Association for Hydraulic Research (IAHR)

Selected Publications

Journal Publications

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Frank Ligon

Senior Aquatic Ecologist, Stillwater Sciences

Mr. Ligon is an aquatic ecologist and geomorphologist specializing in investigations of the role of fluvial processes and morphology in the ecology of stream fish, invertebrates, and plant communities.

Education

MS, Wildland Resource Science (Freshwater Ecology/Fluvial Geomorphology), University of California at Berkeley, 1986

BS, Conservation of Natural Resources, University of California at Berkeley, 1982
Magna Cum Laude
Phi Beta Kappa

Professional Experience

Fisheries Ecology

Mr. Ligon managed a 10-year research program on Tuolumne River chinook salmon ecology and management as part of a hydroelectric relicensing project. Studies included: (1) assessment of predation rates by black bass and squawfish on juvenile salmon, particularly in areas where extensive in-river gravel mining has created long, deep lake-like areas, (2) salmon spawning gravel quality studies examining the size distribution of the stream substrate; the rate of intrusion of fine sediments; the amount of fine sediments removed from the gravels by spawning salmon; salmon embryo survival-to-emergence using emergence traps; and the development of a hydraulic gravel cleaning machine, (3) invertebrate studies examining the effect of stream morphology and hydraulic conditions on benthic and drift densities and species composition, (4) juvenile salmonid studies examining distribution, migration, feeding behavior, food preferences, and growth, (5) examination of the influence of channel and floodplain morphology on stranding mortality of juvenile salmon, (6) spawning gravel availability studies in which gravels with suitable hydraulics and substrate for spawning were mapped as part of an assessment of the effects of the distribution and suitability of spawning habitat on redd superimposition, and (7) assessment of the effects of different summer flow regimes on the distribution and abundance of all fish species in the Tuolumne River (~35 species) and on invertebrates. Mr. Ligon has managed a number of other salmon ecology and restoration projects in California, Oregon, and New Zealand.

Geomorphology and Stream Ecology

Mr. Ligon has been working in conjunction with biologists and geomorphologists from UC Berkeley and Humboldt State University to develop a geomorphologically-based approach to protecting and preserving stream biodiversity below dams. He presented this research as an invited speaker at a symposium on the ecology of large rivers at the 1993 annual meeting of the Ecological Society of America and was lead author of an invited paper on this subject for *BioScience*.

Mr. Ligon managed the fluvial geomorphology component of a hydroelectric relicensing project on the McKenzie River in Oregon. He conducted studies on the longitudinal variation in sediment supply and sediment transport capability, historic changes in channel planform and bar topography, determinants of substrate composition, effects of bank protection on channel morphology, and effects of flood control on channel complexity. He determined that the geomorphic response of the river to flood control dams on two tributaries was leading to a reduction in areas having sufficiently low shear stress to allow for

salmon spawning gravel deposition. Mr. Ligon has also conducted research on fluvial geomorphology and stream ecology on the Noyo River, Clavey River, San Pablo Creek, and many other northern California streams, and has managed the fluvial geomorphology component of a hydroelectric relicensing project on the Oconee River in Georgia.

Watershed Analysis

Mr. Ligon is responsible for the fish habitat, stream channel, and riparian components of the watershed analysis conducted by Louisiana-Pacific and the California Department of Forestry for their sustained yield plans (SYPs) and habitat conservation plans (HCPs) in northern California. As part of this project, he is developing models for assessing channel sensitivity in the field that can be extrapolated over large areas using digital terrain modeling (DTM). He is project manager for a 1,000-square mile watershed analysis in the North Umpqua River basin. This project is incorporating hydroelectric dams and facilities into a watershed analysis and is developing a reference model of stream channel morphology and aquatic habitat to aid in channel assessment and the development of management and mitigation strategies for ecosystem restoration and salmon and trout enhancement. The North Umpqua watershed analysis examined the effect of the hydroelectric project on fish passage, instream flows, anadromous and resident fish, amphibians, water quality, geomorphology, reservoir and forebay habitats, and terrestrial habitat connectivity. Mr. Ligon managed a project for the Eldorado National Forest in California to develop a stream channel assessment procedure that would facilitate interpretation of changes in geomorphic processes and morphology in terms of their implications for aquatic biota.

Aquatic Invertebrate and Algal Ecology

Mr. Ligon used aquatic invertebrates to monitor the effects of timber harvesting, post-fire management, and cattle grazing on stream ecology for the US Forest Service. He designed and conducted a study for the California Department of Forestry on the effects of timber harvest activities on stream algal ecology. He participated in a study examining the effects of stream flow regulation on invertebrate drift and benthic communities and their relation to fish populations and feeding preferences. He has assessed food limitations of juvenile salmon using drift and benthic sampling of aquatic invertebrates, stomach content analysis, juvenile salmon growth rates, and bioenergetic modeling.

Professional Affiliations

American Fisheries Society
North American Benthological Society

Selected Publications and Presentations

Ligon, F.K., A.L. Percival, and T.P. Speed. Submitted. The effects of turbidity on largemouth bass feeding rate and implications for salmon management.

Ligon, F.K., W.E. Dietrich, and W.J. Trush. 1995. Downstream ecological effects of dams: A geomorphic perspective. *BioScience*.

Baker, P.F., T.P. Speed, and F.K. Ligon. 1995. The influence of temperature on the survival of chinook salmon smolts (*Oncorhynchus tshawytscha*) migrating through the Sacramento - San Joaquin River Delta of California. *Canadian Journal of Fisheries and Aquatic Sciences*.

Ligon, F.K. and W.E. Dietrich. 1991. River management for floodplain development and salmon—are they compatible? A geomorphological analysis of a cobble-bedded alluvial river ecosystem. Presented at the Fifth International Symposium on Regulated Streams.

Ligon, F.K. 1990. The effects of predation on salmon population dynamics. Presented at the Pacific Fisheries Biologists Annual Meeting.

Erman, D.C. and F.K. Ligon. 1988. Effects of flow fluctuations and fine sediment additions on stream fish and invertebrates below a water filtration plant. *Environmental Management* 12:85-97.

Bruce Orr, PhD
Senior Ecologist

Dr. Orr has 20 years of experience in population and community ecology of aquatic, terrestrial, and wetland environments in the western United States. His areas of technical expertise include natural resources inventory and management planning, wetlands and freshwater ecology, aquatic entomology, and flora and vegetation of the western United States. He is experienced in wetland delineation and functional assessment; threatened and endangered species surveys; plant community classification and mapping; mitigation planning; and environmental impact assessment. Dr. Orr has managed a number of complex, multi-year projects involving interdisciplinary teams conducting natural resource inventories, assessments, and watershed analysis in a variety of habitats; developing natural resource management plans; and producing environmental impact assessment documents.

Education

Ph.D., Entomology (Ecology/Aquatic Entomology), University of California at Berkeley, 1991

Graduate Studies in Ecology (Aquatic and Population Biology), University of California at Santa Barbara, 1979-1982

B.A., Biological Sciences and Environmental Studies, University of California at Santa Barbara (high honors), 1979

Training

CDFG certification in California Wildlife Habitat Relationships (WHR) system, 1995

Applied Fluvial Geomorphology Course, taught by David Rosgen and Luna Leopold, 1993

National Wetlands Science Training Cooperative Certification in Jurisdictional Delineation of Wetlands, 1993

USFWS Habitat Evaluation Procedures (HEP), 1992

Professional Experience

Integrated Natural Resource Analysis and Management Planning

Dr. Orr is an experienced project manager and interdisciplinary team leader for complex projects involving natural resource inventories, integrated natural resource management plan development, and federal and state regulatory processes. He is currently project manager for development of a multi-species Habitat Conservation Plan (HCP), Sustained Yield Plan (SYP) for timber management, and a joint EIS/EIR for the California Department of Forestry and Fire Protection's 50,000 acre Jackson Demonstration State Forest. Dr. Orr recently served as project manager for Louisiana-Pacific's multi-species HCP and SYP project in northern California. This 3-year project involved conducting watershed, fisheries, and wildlife assessments and the development of SYPs and HCPs covering over 300,000 acres of industrial forestlands owned by Louisiana-Pacific, with a total watershed and wildlife assessment area exceeding one million acres. He served as technical manager for a multidisciplinary effort involving natural resource inventories and development of biodiversity and ecosystem management plans for a 28,000-acre watershed master plan project in the San Francisco Bay Area. Dr. Orr has also served as project manager or technical task leader on a variety of other impact assessment projects addressing the regulatory requirements of NEPA, CEQA, and FERC. Dr. Orr served as an instructor in watershed analysis at the 1998 Watershed Academy, which was sponsored by the University of California, and co-sponsored by California Department of Fish and Game, and National Marine Fisheries Services. He has also presented workshops in various aspects of watershed analysis for the EPA,

NRCS, and California Regional Water Quality Control Boards.

Aquatic Ecology

Dr. Orr has a broad background in general limnology and stream ecology. He has sampled aquatic invertebrates in a wide variety of freshwater and brackish-water habitats; conducted limnological surveys to determine physical and chemical characteristics of lakes and wetlands; conducted experimental studies on interactions among predators, zooplankton, and phytoplankton in lentic systems; applied EPA's Rapid Bioassessment Protocols to examine impacts of hydropower development on stream macroinvertebrates in Southern California; and served as co-manager for a long-term study examining the effects of different summer flow regimes on fish and benthic macroinvertebrate communities in the lower Tuolumne River and experimental studies of the influence of turbidity on the predation of juvenile salmonids by black bass. He has conducted studies of the effects of stream flow on riparian vegetation in the Sierra Nevada and is involved in instream and riparian habitat restoration efforts on the lower Tuolumne River.

Wetlands Biology

Experienced in jurisdictional delineation of wetlands. Designed and conducted field surveys, laboratory experiments, and field experiments on interactions among aquatic vegetation, predators, and macroinvertebrates in freshwater wetlands of California. Conducted investigations of historical changes in geomorphology and salt marsh vegetation, and field surveys of plant distributions, in the San Francisco Bay Area. Expertise in biological control of mosquitoes in wetlands. Experienced in the use of wetland assessment techniques. Recent involvement in studies of palustrine, lacustrine, and riparian wetlands in California, Oregon, and Montana, including studies of ecological relationships among hydrology, vegetation, and wildlife for a large freshwater wetland complex in southern Oregon.

Terrestrial Ecology

Dr. Orr is experienced in field survey techniques and identification of terrestrial plants, insects, and vertebrates. Dr. Orr served as task leader or project manager on a variety of studies assessing project impacts on terrestrial vegetation and wildlife, including plant and wildlife surveys in a variety of habitats in California, Oregon, and Montana. He has 6 years of experience teaching college laboratory and field courses in terrestrial ecology and natural history. His recent experience as project manager or technical task leader includes wildlife habitat assessment using HEP and other techniques for extensive studies of riparian and freshwater marsh habitats in southern Oregon; development of an integrated natural resource management plan for Robins AFB, Georgia; vegetation management environmental assessments and ecological unit inventories for the Angeles and Cleveland national forests; development of multi-species HCPs; and impact assessments for a variety of projects in California. He is currently a member of the California Native Plant Society Vegetation Committee.

Surveys for Rare, Threatened, and Endangered Species

Dr. Orr conducted surveys for rare, threatened, and endangered (RTE) plants and animals, and conducted general floristic and faunal surveys in various wetland, aquatic, and terrestrial habitats in California, Oregon, and Montana. He was recently involved in inventory and mitigation studies of RTE species for projects in the western Sierra Nevada, central California, habitat planning for RTE species in northern California forestlands, and ecological studies of headwater amphibians in Oregon and California.

Professional Affiliations

American Institute of Biological Sciences
California Native Plant Society
Ecological Society of America
North American Benthological Society
Society for Ecological Restoration

Selected Publications and Presentations

Olson, C. and B. Orr. 1998. Combining tree growth, fish and wildlife habitat, mass wasting, sedimentation, and hydrologic models in decision analysis and long-term forest land planning. Forest Ecology and Management 110: 1-10. (Paper presented at First Biennial North American Forest Ecology Workshop, Raleigh, NC. June 23-27, 1997.)

Orr., B.K. 1997. Use of a regional watershed analysis approach in long-term forest management planning in California. Watershed Management Council Networker 7 (3): 1, 4-16, 13.

Orr, B.K. 1997. Ecosystem health and salmon restoration: a broader perspective. Invited paper prepared for a special session on "The role of applied ecological research in the management of a regulated river: New Don Pedro Dam and the Tuolumne River," International Association for Hydraulic Research Conference, San Francisco, CA. August 11-15, 1997.

Lacey, L. and B.K. Orr. 1994. The role of biological control of mosquitoes in integrated vector control. American Journal of Tropical Medicine and Hygiene 50(6) Suppl: 97-115 (invited paper).

Smyth, A.P., B.K. Orr, and R.C. Fleischer. 1993. Electrophoretic variants of egg white transferring indicate a low rate of intraspecific brood parasitism in colonial cliff swallows in the Sierra Nevada, California. Behavioural Ecology and Sociobiology 32:79-84.

Orr, B.K. and V.H. Resh. 1992. Influence of *Myriophyllum aquaticum* cover on Anopheles mosquito abundance, oviposition, and larval microhabitat. Oecologia 90:474-482.

Orr, B.K., S. Morhardt, and R.D. Stone. 1991. Influence of drought on the distribution and abundance of montane riparian plants along a western Sierra Nevada stream. Paper presented at the California Riparian Systems Conference III: Progress in Protection and Restoration, Sacramento, California. 16 November.

Orr, B.K., W.W. Murdoch, and J.R. Bence. 1990. Population regulation, convergence, and cannibalism in *Notonecta* (Hemiptera). Ecology 71(1): 68-82.

Orr, B.K. and V.H. Resh. 1989. Experimental test of the influence of aquatic macrophyte cover on the survival of *Anopheles* larvae. Journal of the American Mosquito Control Assoc. 5:579–585.

Collins, J.N. and B.K. Orr. 1989. An ecological overview of the Coyote Hills wetlands, *in* Talk about Wetlands, Proceedings of the Coyote Hills Wetlands Workshop, 10–11 February 1987, Coyote Hills Regional Park, Fremont, California (J. Collins and K. Burger, eds.), pp. 34–42.

Collins, J.N., E.P. McElravy, B.K. Orr, and V.H. Resh. 1988. Preliminary observations on the effects of the intersection line upon predation of *Anopheles* mosquito larvae. Bicovas (Proceedings of the International Conference on

Biological Control of Vectors with Predaceous Arthropods. Loyola College, Madras, India.) 1:1–12.

Orr, B.K. and V.H. Resh. 1987. Interactions among mosquitofish *(Gambusia affinis)*, Sago pondweed *(Potamogeton pectinatus)*, and the survivorship of *Anopheles* mosquito larvae. Proceedings of the California Mosquito and Vector Control Association 55:94–97.

Orr, B.K. and V.H. Resh. 1986. Spatial-scale considerations in predator-prey experiments. Proceedings of the California Mosquito and Vector Control Association 54:105–109.

Rafael Real deAsua

GIS and Image Processing Analyst

Mr. Real de Asua is a GIS and Image Processing analyst and programmer with 9 years of experience in computerized mapping and GIS and 3 years in image processing. He participates in the analysis, modeling, and execution of the GIS and image processing elements of all projects, using the ESRI ARC/INFO, ERDAS, and Intergraph/Microstation software systems. Mr. Real de Asua designs and codes programs to automate GIS processes on the ARC/INFO platform. He has served as an analyst and programmer for GIS projects for county, state, and federal agencies, including the analysis of land use impacts, forest health, fisheries, ground water pollution, and suitability for residential development.

Education

M.L.A., University of Pennsylvania; Landscape Architecture (GIS specialization); 1990
B.A., Universidad de Zaragoza, Departamento de Geografia, Spain; Physical Geography, with emphasis in Geomorphology; 1983

Professional Experience

Environmental Assessment and Investigation

In support of a Sustained Yield Plan for forests owned by Louisiana-Pacific in California, generated GIS data at a planning watershed level to be used in ecological models of soil erosion, stream channel sensitivity, fish distribution, and hydrology. Tasks included the automation of the production process using ARC/INFO AML language and the determination of a method to automatically calculate stream channel slopes from existing digital data to help in the prediction of fish habitat.

Prepared a GIS for the evaluation of stream channel conditions of various watersheds in Klamath and Eldorado National Forests. Tasks included designing the GIS; transferring data from MOSS to ARC/INFO; generating lattices and contour line maps from USGS 7.5' Digital Elevation Models; supervising data input and performing quality control; and writing software to calculate longitudinal slopes of streams and to automate plotting.

In support of a regional watershed plan, built a regional spatial database at several scales and executed database queries for economic and water quality consultants charged with impact assessments. Wrote software to check and display minimum distances from tax parcels to water bodies to facilitate automating the data entry and reformatting of more than 40,000 records from tax parcel information into the ARC/INFO format, to automate the generation of different buffers for hydrologic elements; to locate land parcels subject to future development; to develop templates for plotting different maps; and to automate the scaling of plots from A size to E size.

For a Remedial Investigation and Feasibility Study of the Passaic River, New Jersey, generated outfall location, bathymetric changes, and chemical sample location maps. Tasks included incorporating all digital and non-digital data, ranging from databases to aerial photographs and surveying maps, into a GIS; generating bathymetric models for 1989 and 1949; map setup; and cartographic production.

To support the development of an environmental plan to locate areas for timber harvesting in the Shasta-Trinity National Forest, developed a GIS; imported MOSS data from 8 mm tape into ARC/INFO format; participated in the determination of sample plots; and coded, queried, analyzed, and plotted point,

line, and polygon features for field maps and final reports.

For the Bureau of Indian Affairs, performed quality control on digitized data, queried and generated reports based on vector and raster queries performed in ARC/INFO to be incorporated in hydrologic models.

For the Los Angeles Department of Water and Power, set up a GIS of the Owens River between Crawley Dam and Pleasant Valley Reservoir to define stream channel conditions for use in different sedimentation analyses. Wrote macros to automate plotting.

For the monitoring of carbon monoxide in the Amazon Basin, proposed a program and an accompanying GIS to be used by several Native American peoples and nongovernmental organizations (NOGS) in Peru, Bolivia, and Ecuador. Traveled to the sites, interviewed the local authorities, assessed existing materials and needs, discussed the possible solutions, and wrote a report with recommendations.

To evaluate the impacts of air pollution, created a model to estimate the number of people and land use properties affected by high, medium, and low concentrations of plutonium and several other contaminants in the air between 1950 and 1990. Wrote software to automate the importation of data from TIGER files (Digital Census Information) into ARC/INFO, to determine the population affected, and to generate the plots. For the siting of residential developments for a science city in Taiwan, built a demonstration in ARC/INFO showing several scenarios using development indexes based on transportation, location, and natural factors.

For the development of a GIS prototype for the island of St. John (U.S. Virgin Islands), participated in the development of a potential erosion test model in ARC/INFO.

For the creation of a regional ground water assessment program, participated in the creation of a land use map based on the Anderson Class II classification, made from aerial photographs; helped in data processing and cleaning coverages. Wrote software to translate data from ARC/INFO to Intergraph/Microstation and vice versa and for data quality control.

Land Cover and Vegetation Classification

For the Georgia Power Company, participated in the image processing and classification of bottomland hardwoods. Advised in the selection of training sites and performed supervised and unsupervised classifications with ERDAS; transferred data between ERDAS and ARC/INFO, and in ARC/INFO between raster and vector modules; processed data in ARC/INFO both in the raster module (GRID) as in the vector module (ARC).

For the Bureau of Indian Affairs, conducted supervised and unsupervised classifications of different types of wetland areas in ERDAS IMAGINE (v. 8.1); transferred data between ERDAS and ARC/INFO, and overlaid the results with other layers from the GIS.

Helped in the classification of 24 types of vegetation cover in Central Spain. Generated a classification of the existing vegetation; advised on the number and types of classes to be classified; selected training areas; and participated in the classification of Thematic Mapper and SPOT images.

Participated in the classification of 22 types of land cover in the Basque Country

(Spain). Designed the classification; classified stereoscopic pairs of aerial photographs; ground-truthed the classification; and wrote a report and documentation.

GIS Inventory

For the East Bay Utility Municipal District (EBMUD), participated in the creation of a natural factor GIS. Participated in the design of the GIS, supervised and performed quality control on different layers of the GIS, analyzed and queried the data, plotted maps at different scales and paper sizes, and backed up, documented, and prepared the information for delivery on 8 mm or 4 mm tapes.

For Robins AFB, Georgia, participated in the incorporation of all available environmental data into an Interstation GIS running on an Intergraph workstation. Prepared data input and analysis modules for all categories of information collected in ARC/INFO.

For the City of Newark, New Jersey, and for West Philadelphia, Pennsylvania, developed a GIS of natural factors . Tasks included database design and building, data input, transfer, processing and analyses, and documentation.

Ecological Planning and Design

For Randolph AFB developed a grounds maintenance plan to be included in the Integrated Natural Resources Management Plan. Tasks included a site visit, discussions with the client to focus on the most viable plan, development of the outline, and report writing.

For Robins AFB participated in the Natural Resources Development Plan. Tasks included the preparation of opportunities and constraints matrix for six proposed alternatives on non-active military areas within the base, and participation in the discussions for the weighting of alternatives.

For the Basque Autonomous Government, at the request of the Department of Agriculture wrote a report criticizing the Proposed General Land Use Plan.

Participated in the ecological design of several zoo exhibits for different zoos in the United States and Canada: Savanna/Waterhole Exhibit in Brookfield Zoo, Chicago; Great Ape Exhibit in Denver; Taiga/Northern Forests Exhibit, Seattle; General Master Plan, Toronto Zoo, Toronto. Participated in the design and preparation of the construction documents for the zoos.

Software Application Development

Programming for conversion of data from IGDS to ARC/INFO format and vice versa. Import and formatting of data from tape (ASCII, EBCDIC, DLG, TIGER) files into ARC/INFO. Created templates for plotting and for re-scaling plots. Programming to check visually the distances between geographic elements. Development of window interfaces in ARC/INFO.

List of Skills

GIS applications: ESRI ARC/INFO in UNIX environment; Intergraph SPAN/SPED in VMS environment and Microstation PC/workstation.

Computer Programming: ESRI Arc Macro language (AML); Intergraph User Commands; AWK; C.

Image Processing and Aerial Photointerpretation: ERDAS; Infrared and True color photointerpretation (orthophotos or stereoscopic).

GIS System Management: Workstation and microcomputer system management and customization in Unix environment.

Fluent in French and Spanish.

Professional Societies

Bay Area Automatic Mapping Association (BAAMA), the Bay Area chapter of the Urban and Regional Information Systems Association (URISA)

California Geographic Information Association (CGIA)

Selected Publications

Leven, A. and R. Real de Asua. 1996. Effective GIS Display for Public Involvement Meetings. Poster. 1996 Soil and Water Conservation Society, Keystone Resort, Colorado.

Real de Asua, R. 1996. Predicting Fish Habitat Using Geographic Information Systems. Poster. 1996 ESRI Users Conference. Palm Springs, California.

Real de Asua, R. 1996. Hayfork AMA Forest Health Analysis. Presentation. 1996 California GIS Conference. San Francisco, California.

Real de Asua, R. and J. Zablotney. 1995. Hayfork AMA Forest Health Analysis. Poster. 1995 ESRI Users Conference, Palm Springs, California. Published in the ESRI Map Book, Volume 11 (1995).

John C. Stella

Riparian ecologist, Stillwater Sciences

Mr. Stella has five years of experience in the ecology, geomorphology, and restoration of riparian, aquatic and terrestrial environments in the western United States. His areas of technical expertise include vegetation community classification and mapping; plant taxonomy, physiological and community ecology of the western United States; rapid bioassessment using macroinvertebrate family biotic indices; and stream channel analysis and restoration using biotechnical methods. Mr. Stella has managed stream restoration projects for several Northern California agencies and has designed a field mapping system for a University of California experimental forest.

Education

M.S., Environmental Science, Policy and Management, University of California at Berkeley, 1998.
Concentration in riparian and stream ecology

B.A., Architecture, Yale University, New Haven Connecticut, 1988.
Cum Laude, Distinction in the Major

Awards

Departmental Fellowship, 1996-97 and 1997-98, University of California, Berkeley

Training

CEQA Workshop for Environmental Planners, California Association of Environmental Professionals, 1998

Watershed Analysis, Stream Restoration Design and Implementation Methodology, Waterways Restoration Institute, 1998

Rapid Bioassessment Protocol using a Family Biotic Index, University of California at Berkeley, 1997

Stream Habitat Assessment, University of California at Berkeley, 1997

Professional Experience

Riparian and Watershed Ecology

Mr. Stella has five years of experience in watershed and riparian ecology. He has implemented a long-term stream habitat and vegetation monitoring plan for the University of California at Berkeley's Blodgett Forest Research Station. As part of that effort, he designed a field-based stream habitat mapping system for monitoring permanent plots on the experimental forest, and conducted forest inventory and riparian vegetation plot surveys. Mr. Stella has extensive understanding of riparian plant physiology and community ecology, and the geomorphologic, hydrologic and nutrient dynamic processes that occur in riparian zones. As part of his Masters work, he organized and led a graduate seminar on the geomorphological and ecological linkages in watershed processes in the Department of Integrative Biology at University of California at Berkeley. Mr. Stella is also trained in the EPA's Rapid Bioassessment Protocols using macroinvertebrate family biotic indices. He has sampled aquatic invertebrates in a wide variety of freshwater and estuarine habitats, and has conducted surveys of urbanized and natural reaches of both perennial and intermittent streams in Northern California.

Stream Channel

Restoration and Rehabilitation

Mr. Stella is an experienced project manager on stream channel restoration, rehabilitation and maintenance projects. As a consultant for the Waterways Restoration Institute in Berkeley, CA, he supervised the implementation of stream restoration plans for urban waterways draining to San Francisco Bay. His job responsibilities included coordinating public agencies, construction subcontractors and project designers to ensure that projects met design, regulatory and ecological goals; site surveying, data analysis, implementing soil bioengineering techniques, and supervising a work crew.

As a project coordinator for the East Bay Conservation Corps in Oakland, CA, Mr. Stella developed and managed a wide variety of conservation, restoration and maintenance projects on East Bay streams and flood channels. Projects included a $350,00 annual contract with the Alameda County Flood Control District for vegetation removal and channel maintenance; reach-scale channel restoration projects using soil bioengineering methods for the San Francisco Water Department and the East Bay Asian Development Corporation; and fuel break construction on Alameda Creek for the Alameda County Water Department. Mr. Stella directly supervised 5 site supervisors and their crews of 6-10 employees. Other responsibilities included writing and implementing the agency's field staff training plan and coordinating corpsmember orientation, leadership training, crew on-site education, agency-side community meetings and life skills workshops for 100+ participants and 30 staff.

Professional Affiliations

Ecological Society of America
California Native Plant Society
The Nature Conservancy

Selected Publications

Stella, J.C. 1998. The Greywacke Cover-up. Soil Survey Horizons 39(4): 127-130.

Jennifer C. Vick

Ecologist/Geomorphologist

Ms. Vick has more than ten years experience in ecology and geomorphology. Her areas of expertise include geomorphology, hydrology, sediment transport analysis, and riparian and aquatic ecology. She is experienced in historic geomorphic assessment, sediment transport analysis, hydraulic and hydrologic analyses, and field surveying methods, as well as invertebrate and fish sampling, vegetation analysis, and environmental assessment. Ms. Vick is also experienced in project planning and managing and has worked on restoration plans for several California streams and rivers.

Education

M.L.A., *Environmental Planning*, University of California at Berkeley 1995
Graduate Studies in Marine Biology and Marine Sciences, University of Oregon and University of California at Santa Cruz (1988-1989)
B.S., *Zoology*, University of Georgia, Athens, Georgia, 1988
Magna Cum Laude
Phi Beta Kappa

Professional Experience

Geomorphology and Hydrology

Ms. Vick has conducted geomorphic and hydrologic analyses on the Merced, Tuolumne, and Stanislaus Rivers. She completed an extensive analysis of geomorphic trends in the Merced River, including assessment of the hydrologic and geomorphic impacts of dams and instream and floodplain mining. Her work included field surveys and interpretation, aerial photograph interpretation, digital mapping and analysis, and extensive application of statistical methods to hydrologic data. From her analysis, she proposed three restoration approaches that could be developed for the Merced River. Ms. Vick presented the results of her research at a meeting of the American Geophysical Union in 1995. The University of California Water Resources Center published a summary of her thesis in 1996. This study was the first extensive geomorphic study conducted in this river corridor.

In 1995, Ms. Vick (with Dr. G.M. Kondolf and Timothy Ramirez) evaluated the performance of three reconstructed spawning riffles on the Merced, Tuolumne, and Stanislaus Rivers. She conducted field surveys and hydraulic and sediment transport analyses which documented actual and predicted bed mobility at the riffle reconstruction sites. The results of this research were published by the University of California Water Resources Center and in the Transactions of the American Fisheries Society.

On the Cosumnes River, Ms. Vick conducted the geomorphic component of a large-scale floodplain restoration plan developed for The Nature Conservancy. She assessed historic changes in channel planform and cross section, changes in sediment transport capacity caused by channel incision and levees (floodplain constriction), floodplain sedimentation at restored sites, and hydrology and flood attenuation. Her work included interpretation of historic maps and surveys, planning and interpretation of current channel surveys, interpretation and assessment of watershed geology, sediment transport modeling, and hydrologic analysis.

Ms. Vick has also conducted geomorphic assessments and developed management or restoration recommendations on urban and rural streams in Alameda, Contra Costa, and Santa Cruz Counties. She has also worked extensively on the application of geomorphic, hydraulic, and hydrologic

information to the planning and design of ecological restoration projects.

Ecology

At the University of Georgia, Ms. Vick participated an ecological evaluation of microhabitat partitioning of native fishes in cold-water streams. Her work included invertebrate and fish sampling and identification and processing of benthic macroinvertebrate samples.

Ms. Vick spent four years as an ecologist at the Corps of Engineers. During this time, she evaluated the environmental impacts of a variety of projects and provided technical input to the development of wetland and riparian mitigation and monitoring plans. She developed guidelines for monitoring vegetation and channel morphology at riparian habitat mitigation sites. These guidelines are used by the Corps of Engineers San Francisco District and were adopted by the Texas Department of Parks and Wildlife. She also served on or chaired several technical advisory committees which developed restoration plans for the Salinas River, Russian River, and Carmel River lagoons; Bolinas Lagoon; and Muir Beach (Big Lagoon).

Ms. Vick participated in an analysis of the ecological values of floodplain and terrace aggregate mining pits in central California. With research assistants from the University of California, she sampled riparian vegetation established at these pits and developed relationships between surface slope, soil quality, and vegetation vigor and extent. Results of this research were presented at a meeting of the Society for Ecological Restoration.

Environmental Compliance

Ms. Vick has four years experience in environmental regulation. She has prepared more than fifty environmental assessments and has managed the preparation of three Environmental Impact Reports/Statements. She has also participated in formal and informal endangered species consultations with the U.S. Fish and Wildlife Service and has coordinated with the California Department of Fish and Game, National Marine Fisheries Service, Environmental Protection Agency, and Regional Water Quality Control Board.

Professional Affiliations

American Geophysical Union
Ecological Society of America
Society for Ecological Restoration
Society of Wetland Scientists
California Native Plant Society

Selected Publications

Kondolf, G.M., J.C. Vick, and T.M. Ramirez. 1996. Salmon Spawning Habitat Rehabilitation in the Merced, Tuolumne, and Stanislaus Rivers, California: An Evaluation of Project Planning and Performance. University of California Water Resources Center Report No. 90, Davis, CA.

Kondolf, G.M., J.C. Vick, and T.M. Ramirez. 1996. Salmon Spawning Habitat Rehabilitation in the San Joaquin Valley, California: An Evaluation of Project Planning and Performance. Transactions of the American Fisheries Society 125:899-912.

Vick, J.C. 1995. Channel Change from Dam Construction and Instream Gravel Mining in the Lower Merced River, California: Implications for Restoration of Native Salmonid Populations, EOS Trans AGU, 76(17), Spring Meeting Supplement, S152.

Vick, J.C. 1995. Codornices Creek Restoration Project: Channel Hydraulics and Sediment Transport. Prepared for Andrea Lucas Associates, Berkeley, CA.

Vick, J.C. 1995. Habitat Rehabilitation in the Lower Merced River: A Geomorphological Perspective (Masters Thesis). Center for Environmental Design Research Report Numbers CEDR-03-95 and CEDR-04-95, University of California at Berkeley, Berkeley, CA.

Kondolf, G.M. and J.C. Vick. 1995. Spawning Gravel Resources in the Lower Tuolumne River: Hydrologic and Geomorphic Studies and Review of Existing Information (Draft). Prepared for the Oakridge National Laboratory Environmental Science Division, Oakridge, Tennessee.

Vick, J.C.. 1994. Guidelines for Monitoring Riparian Mitigation Projects. U.S. Army Corps of Engineers, San Francisco District, San Francisco, CA.

Kendall, T.R., J.C. Vick and L. Forsman. 1991. Sand as a Resource - Managing and Mining the Northern California Coast. Proceedings of the Seventh Symposium on Coastal and Ocean Management, ASCE, NY, NY.

Presentations to Professional Meetings and University Classes

"Habitat Rehabilitation in the Lower Merced River: A Geomorphological Perspective" - Guest lecture in Geomorphology in River and Stream Restoration, University of California Extension, (April 1995, 1996, 1997) and Hydrology for Planners (LA 222), University of California, April 1996.

"Wetland Regulatory Process and the Role of Compensatory Mitigation" - Guest lecture in Hydrology for Planners (LA 222), University of California, March 1995 and April 1996.

"Channel Change from Dam Construction and Instream Gravel Mining in the Lower Merced River, California: Implications for Restoration of Native Salmonid Populations" - Presentation to the American Geophysical Union Special Session to Honor the Career of M. Gordon Wolman, June 1995.

"Wetland Mitigation: Policy or Poker Chip?" - Guest lecture in Landscape Architecture and Environmental Planning Colloquium (LA 253), University of California, October 1994.

"Wetland Mitigation - Projects and Policy" - Guest lecture in Restoration of Rivers and Streams (LA 254), University of California, October 1993.

APPENDIX D

Short CURRICULUM VITAE
Selected Materials Related to River Valley Resource Management

Name:	Stewart Boone ROOD
Birth:	February 1, 1955, San Francisco, CA, USA
Citizenship:	dual: American and Canadian - naturalized Jan. 5, 1977.
present address:	Department of Biological Sciences University of Lethbridge, Lethbridge, Alberta, Canada T1K 3M4 phone: (403) 329-2327home: (403) 320-9601 fax: (403) 329-2082 email: ROOD@ULETH.CA

Education

B.Sc.	(with Distinction) Psychology-Biology, University of Alberta. 1976.
Ph.D.	Plant Physiology, University of Calgary. 1981.

Post-Doctoral Awards:

NSERC Postdoctoral Fellowship, Univ. of Toronto. 1981 to 1983.
NSERC University Research Fellowship, Univ. of Lethbridge. 1983 to 1988.
Dr. E.E. Ballantyne Award For Excellence in Environmental Research. 1989. From the Alberta Environmental Research Trust.
The C.D. Nelson Award. 1992. Outstanding contributions by a young plant physiologist in Canada, From the Canadian Society of Plant Physiologists.

Employment

1995-1997	- Coordinator, Environmental Science Program, University of Lethbridge
1993-present	- Professor, University of Lethbridge
1991-1994, 1997	- Chair, Department of Biological Sciences, University of Lethbridge
1989 (Fall)	- Royal Society (London) Visiting Research Fellow, Hormone Biochemistry, Long Ashton Research Station, Bristol, England
1989 - 1993	- Associate Professor, University of Lethbridge - Appointed Adjunct Associate Professor, University of Calgary
1988 (Spring)	- Visiting Research Professor, Department of Plant Physiology and Microbiology, University of Tromso, Norway
1983-1988	-NSERC University Research Fellow and Assistant Professor of Biology (Botany), University of Lethbridge
1981-1983	-NSERC Post-Doctoral Research Fellow, Faculty of Forestry, University of Toronto

Selected Publications in Refereed Journals

Kranjcec, J., J.M. Mahoney and S.B. Rood. 1998. The responses of three riparian cottonwood species to water table decline and implications for branch propagation. Forest Ecology and Management 110: 77-87.

Mahoney, J.M. and S.B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment - an integrative model. Wetlands 15: 634-645.

Rood, S.B., A.R. Kalischuk and J.M. Mahoney. 1998. Initial cottonwood seedling recruitment following the flood of the century of the Oldman River, Alberta, Canada. Wetlands 15: 557-570.

Willms, J., S.B. Rood, W. Willms and M. Tyree. 1998. Branch growth of riparian cottonwoods: a hydrologically sensitive dendrochronological tool. Trees 12:215-223.

1997

Kalishchuk, A.R., L.A. Gom, K.D. Floate and S.B. Rood. 1997. Intersectional cottonwood hybrids are

particularly susceptible to the poplar bud gall mite. Can. J. Bot. 75:1349-1355.

1996

Rood, S.B. and J.M. Mahoney. 1996 River damming and riparian cottonwoods along the Marias River, Montana. Rivers

1995

Rood, S.B., J. M. Mahoney, D. E. Reid and L. Zilm. Instream flows and the decline of riparian cottonwoods along the St. Mary River, Alberta. Canadian Journal of Botany 73:1250-1260

1994

Rood, S.B., C. Hillman, T. Sanche and J.M. Mahoney. 1994. Clonal reproduction of riparian cottonwoods in Southern Alberta. Can. J. Botany. 72:1766-1770.

Tyree, M., K. Kolb, S.B. Rood and S. Patino. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta: A possible role in decline of the ecosystem. Tree Physiology. 14:455-466.

Zanewich, K. and S.B. Rood. 1994. Endogenous gibberellins of alder, aspen and birch. J. Plant Growth Regulation. 13:159-162.

1993

Campbell, J.S., J.M. Mahoney, and S.B. Rood. 1993. A lack of heterosis in natural poplar hybrids from southern Alberta. Can. J. Botany 71:37-42.

1992

Mahoney, J.M. and S.B. Rood. 1992. Response of a hybrid poplar to water table decline in different substrates. Forest Ecol. and Management 54:141-156.

1991

Greenaway, W., S. English, F.R. Whatley, and S.B. Rood. 1991. Interrelationships of poplars in a hybrid swarm as studied by gas chromatography-mass spectrometry. Can. J. Botany. 69: 203-208.

Mahoney, J.M. and S.B. Rood. 1991. A device for studying the influence of declining water table on poplar growth and survival. Tree Physiol. 8: 305-314.

1990

Neuman, D.S., S.B. Rood and B.A. Smit. 1990. Does cytokinin transport from root-to=shoot in the xylem sap regulate leaf responses to root hypoxia? J. Exp. Bot. 41: 1325-1333.

Rood, S.B. and J.M. Mahoney. The collapse of poplar forests downstream from dams in the Western Prairies: probable causes and prospects for mitigation. Environmental Management. 14:451-464.

1989

Rood, S.B. and S. Heinze-Milne. 1989. Abrupt downstream forest decline following river damming in southern Alberta. Can. J. Bot. 67:1744-1749.

Rood, S.B. and Juntilla O. 1989. Lack of influence of photoperiod on the metabolism of gibberellin A_{20} in *Salix pentandra*. Physiol. Plant 75:506-510.

1988

Bate, N.J., S.B. Rood, and T.J. Blake. 1988. Gibberellins and heterosis in poplar. Can. J. Bot. 66:1148-1152.

Rood, S.B., N.J. Bate, L.N. Mander, and R.P. Pharis. 1988. Identification of gibberellins A_1 and A_{19} from *Populus balsamifera* x *P. deltoides*. Phytochemistry 27:11-14.

1986

Rood, S.B., J.S. Campbell, and T. Despins. 1986. Natural poplar hybrids from southern Alberta. I. Continuous variation for foliar characteristics. Can. J. Bot. 64:1382-1388.

1984

Rood, S.B., G. Daicos, and T.J. Blake. 1984. Gibberellic acid induced growth acceleration in *Populus* hybrids. Can. J. For. Res. 14:850-854.

Other Publications

1994

Willms, J. and S.B. Rood. 1994. Instream flows and riparian cottonwoods along the Bow River, southern Alberta. prepared for Alberta Environmental Protection, Edmonton, AB. 54 pp.

1993

Mahoney, J.M. and S.B. Rood. 1993. A model for assessing the effects of altered river flows on the recruitment of riparian cottonwoods. proceedings from: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico, USDA Technical Report RM-226.pp. 227- 232..

Mahoney, J.M. and S.B. Rood. 1993. The potential effects of an operating plan for the Oldman River Dam on riparian cottonwood forests. prepared for Alberta Public Works, Supply and Services, Edmonton, AB. 108 pp. + 83 pp. appendices.

Rood, S.B. and C. Bradley. 1993. Assessment of riparian cottonwoods along the Bow River downstream from Calgary, Alberta. University of Lethbridge. 63 pages.

Rood, S.B. and J.M. Mahoney. 1993. River Damming and Riparian Cottonwoods: Management Opportunities and Problems. proceedings from: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico. USDA Technical Report RM-226. pp. 134-143.

1992

Rood, Stewart. 1992. Chinook Country Rivers: Dammed But Not Forgotten. pages 83 to 98 in ÔFlowing to the Future - 1991Õ. edited by G. Hanna, T. Pyrch, and C. V. Smith. University of Alberta (Edmonton).

Rood, S.B. and J.M. Mahoney. 1992. Instream flow needs for riparian vegetation: riparian cottonwood forests. Instream flow neeeds seminar proceedings, Alberta Environment, Edmonton.

1991

Kocsis, M., J.M. Mahoney and S.B. Rood. 1991. Effects of substrate texture and rate of water table decline on transpiration and survival of poplar species. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 63-67.

Lee, C., J.M. Mahoney and S.B. Rood. 1991. Poplar seeds and seedlings along the St. Mary, Belly and Waterton Rivers, Alberta. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 85-90.

Mahoney,J.M., P. Koegler and S.B. Rood. 1991. The accuracy of tree ring core analysis for estimating the age of riparian poplars. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 25-30.

Mahoney, J.M. and S.B. Rood. 1991. A model for assessing the impact of altered river flows on riparian poplars in southwestern Alberta. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 99-104.

Rood, S.B. and J.M. Mahoney. 1991. The effects of river damming on cottonwood forests in southern Alberta. In: J. Byrne and C. Fleming (eds.) Proceedings of Irrigation Research and Development Conference - 1990. University of Lethbridge. pp. 469-476.

Rood, S.B. and J.M. Mahoney. 1991. The importance and extent of cottonwood forest decline downstream from dams. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 1-9.

Stobbs, K., A. Corbiere, J.M. Mahoney and S.B. Rood. 1991. Influence of rate of water table decline on establishment and survival of hybrid poplar seedlings. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 47-53.

Virginillo, M., J.M. Mahoney and S.B. Rood. 1991. Effects and survival of poplar seedlings along the Oldman River, Southern Alberta. In: S.B. Rood and J.M. Mahoney (eds.) The Biology and Management of Southern Alberta's Cottonwoods. pp. 55-61.

1990

Rood, S.B. 1990. The parched Oldman: Vanishing rivers in southern Alberta. In: Flowing to the Future. University of Alberta pp. 131-144. (invited, non-refereed).

Rood, S.B. and J.M. Mahoney. 1990. The collapse of river valley forests downstream from dams in the Rocky Mountain foothills. In: Delisle, C.E. and M.A. Bouchard (eds.) Managing the effects of hydroelectric development. Collection Environment et Geologie, Univ. de Montreal. Can. Soc. Environ. Biol. pp. 417-430. (invited, non-refereed).

1988

Rood, S.B. 1988. Potential impact of the Oldman River Dam on downstream vegetation. In: S.B.Rood and F.J. Jankunis (eds.) Economic, Environmental, and Social Aspects of the Oldman River Dam Project. University of Lethbridge. pp. 137-144. (invited, non-refereed).

Rood, S.B. 1988. The Coalbanks Canal, Lethbridge: A demonstration of multiple-use water management. In: The CAOC Water Conference - Notes from a Canadian Conference. pp. 209-214. (invited, non-refereed).

Other Invited Conference Presentations

1993

Mahoney, J.M. and S.B. Rood. 1993. A model for assessing the effects of altered river flows on the recruitment of riparian cottonwoods. conference: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico, Feb. 4-6. (poster).

Rood, S.B. and J.M. Mahoney. 1993. River Damming and Riparian Cottonwoods: Management Opportunities and Problems. conference: Riparian Management: Common Threads & Shared Interests. Albuqueque, N.Mexico, Feb. 4-6. (invited oral presentation).

Some Research Grants Recently Held

NSERC Operating Grant - Gibberellins and crop growth regulation. - $44,426 for 1995/6.

NSERC Strategic Grant - Biology and Preservation of River Valley Cottonwoods - $56,000 to $61,500 per year 1995 to 2000

NSERC Partnership Grant - Evaluation of hormone content in Populus species - $10,000 to $20,000 per year 1996 to 1999

Some Research Contracts Recently Held

Alberta Environment. Riparian Cottonwoods and the Operation of the Oldman River Dam. $15,000 for 1993; $10,000 for 194; $10,000 for 1995.

Alberta Environmental Protection. Instream flow needs for riparian cottonwoods along the Bow and South Saskatchewan rivers. $10,000 per year 1994 to 1996.

Alberta Public Works and Services - Contract - Mitigation and Monitoring of the influence of the Oldman Dam on Downstream Poplar Forests - $45,000 for 1991/92.

United States Department of Agriculture - Forest Service - Cooperative Agreement - Role of Xylem Disfunction in the Decline of Riparian Forest Ecosystems. - $14,100 for 1993/94

United States Fish & Wildlife Service. - Instream flows for riparian restoration along the Truckee River, Nevada. $36,000 for 1995.

Partially Revised: Dec. 1998

Dr. JOHN M. MAHONEY, P.Biol.

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Home Address

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SKILLS and ABILITES

- over 15 years experience leading and working effectively within interdisciplinary groups
- postgraduate training in integrated planning augmented with over 11 years experience
- proven delivery of programs within time and financial constraints
- equally able to relate to and deal with, the public, professionals, and elected personnel

EDUCATION

U. of Calgary	Doctor of Philosophy (Riparian Ecology)	1992-96
U. of Calgary	Master of Environmental Design (Environmental Management)	1980-84
U. of Calgary	Bachelor of Science (Animal Biology)	1978-80
U. of Waterloo	Honours Bachelor of Science (Science)	1972-76

AWARDS

University of Calgary Silver Anniversary Graduate Fellowship	1994/95
Province of Alberta Graduate Fellowship, University of Calgary (declined)	1993/94
NSERC Post Graduate Award - University of Calgary	1992 - 1994
Faculty of Graduate Studies Award, University of Calgary	1992 - 1994
Graduate Assistantship (Research) - University of Calgary	1983/84

RELEVANT EXPERIENCE

Current Position:

Senior Environmental Biologist **1993-present**
Alberta Environmental Protection

- member of interdepartmental Oldman River Dam Environmental Monitoring Committee
- co-ordinated Oldman River Dam wildlife monitoring program with regional wildlife biologists to maximize value of studies
- collaborated with Fisheries biologists to integrate mitigation projects and monitoring with Fisheries Management programs to provide an effective overall program
- completed field studies into the environmental effect of the Oldman River Dam (ORD)
- worked closely with Branch engineers and technologists to ensure integration of hydrological requirements for cottonwoods with real time operations in the basin
- assessed compliance of ORD operations with respect to Fish Rule Curve requirements
- reviewed instream projects to ensure compatibility with Fisheries Management objectives

Research Associate **1988-1993**
University of Lethbridge

- developed a program to integrate the needs of downstream riparian ecosystems without impeding the normal operations of onstream dams
- managed and supervised up to 4 seasonal field personnel
- investigated the effect of the Oldman River Dam Project on downstream riparian ecology
- invented a device for testing the effect of dynamic water tables on plants

Professional Affiliations

Alberta Society of Professional Biologists
Canadian Society of Environmental Biologists

Other Interests

Lethbridge Community College - Program Advisory Committee - member for Renewable Resource Management, and Fish and Wildlife Technology Programs, 1997-present

International Canoe Federation - International Judge for Slalom and Wildwater certification
- Canadian Official to Olympic Games, Atlanta, 1996

PUBLICATIONS and REPORTS

Doctoral Thesis

Mahoney, J.M., 1996. *How River Hydrology Affects the Establishment and Growth of Riparian Poplars.* Department of Geography, University of Calgary, Alberta.

Masters Degree Project

Mahoney, J.M., 1984. *An Evaluation of Shelterbelt Development in Alberta.* Faculty of Environmental Design, University of Calgary, Alberta.

Refereed Publications

J. Kranjec, J.M. Mahoney & S.B. Rood, 1998. *The Response of Three Riparian Cottonwood Species to Water Table Decline.* Forest Ecology and Management, 110:77-87.

J.M. Mahoney & S.B. Rood, 1998. *Streamflow Requirements for Cottonwood Seedling Recruitment – An integrative model.* Wetlands, 18(4):634-645.

S.B. Rood, A.R. Kalischuk & J.M. Mahoney, 1998. *Initial Cottonwood Seedling Recruitment Following the Flood of the Century of the Oldman River, Alberta, Canada.* Wetlands, 18(4):557-570.

S.B. Rood & J.M. Mahoney, 1995. *River Damming and Riparian Cottonwoods along the Marias River, Montana.* Rivers, 5(3):195-207.

S.B. Rood, J.M. Mahoney, D.E. Reid & L. Zilm, 1995. *Instream Flows and the Decline of Riparian Cottonwoods along the St. Mary River, Alberta.* Canadian Journal of Botany, 73:1250-1260.

S.B. Rood, C. Hillman, T. Sanche & J.M. Mahoney, 1994. *Clonal Reproduction of Riparian Cottonwoods in Southern Alberta.* Canadian Journal of Botany, 72:1766-1774.

J.S. Campbell, J.M. Mahoney & S.B. Rood, 1993. *A Lack of Heterosis in Natural Poplar Hybrids from Southern Alberta.* Canadian Journal of Botany, 71:37-42.

J.M. Mahoney & S.B. Rood, 1992. *Response of Hybrid Poplar to Water Table Decline in Different Substrates.* Forest Ecology and Management, 54:141-156

J.M. Mahoney & S.B. Rood, 1991. *A Device for Studying the Influence of Declining Water Table on Poplar Growth and Survival.* Tree Physiology, 8(3):305-314.

S.B. Rood & J.M. Mahoney, 1990. *The Collapse of River Valley Forests Downstream from Dams in the Western Prairies: Probable causes and prospects for mitigation.* Environmental Management, 14(4):451-464.

R. Bell, R. Coote, M. Copeman, T. Duguid, J. Mahoney, M. McCallum & B. Pitman, 1982. *The Road Not Taken: Transportation planning in Banff National Park.* Alternatives, 11(25-30).

J.M. Mahoney & H.I. Rosenberg. 1981. *Anatomy of the Tail in the Beaver Castor canadensis*. Canadian Journal of Zoology, 59(3):390-399.

Non-refereed Publications and Major Reports

J.M. Mahoney, 1996. *The Effect of the 1995 Oldman River Flood on Riparian Cottonwood Forests*. Canadian Water Resources Association Technical Supplement, Summer. 3p.

J.M. Mahoney & S.B. Rood, 1993. *The Potential Effects of an Operating Plan for the Oldman River Dam on Riparian Cottonwood Forests*. Oldman River Dam Mitigation Program Downstream Vegetation Project Report Volume II. Alberta Public Works Supply and Services, Edmonton. 180p.

C.E. Bradley F. Reintjes & J.M. Mahoney, 1991. *The Biology and Status of Riparian Poplars in Southern Alberta*. World Wildlife Fund Canada and Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife, Edmonton. 101p.

Hardy BBT Limited & University of Lethbridge, 1991. *Riparian Vegetation of St. Mary, Belly and Waterton River Valleys, Alberta*. Planning Division, Alberta Environment, Edmonton. 102 p. plus appendices.

S.B. Rood & J.M. Mahoney, 1991. *The Biology of Riparian Cottonwood Forests in the Oldman River Basin*. Oldman River Dam Mitigation Program Downstream Vegetation Project Report Volume I. Alberta Public Works Supply and Services, Edmonton. 150p.

S.B. Rood & J.M. Mahoney, 1991. *Impacts of the Oldman River Dam on Riparian Cottonwood Forests Downstream*. University of Lethbridge, Biological Sciences. 34p.

S.B. Rood & J.M. Mahoney (eds.). 1991. *Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference*. May 3,4, 1990. University of Lethbridge, Alberta. 124p.

J.M. Mahoney & S.B. Rood, 1990. *Developing Operations Rule Curves to Maintain Poplar Forests Downstream from the Oldman River Dam*. Alberta Public Works supply and Services, Edmonton. 6p.

S.B. Rood & J.M. Mahoney, 1989. *River Damming and River Valley Poplar Forests in the Oldman River Basin: Background and initial analysis*. Alberta Public Works Supply and Services, Edmonton. 75p.

J.M. Mahoney, 1985. Pattern Recognition of Remotely sensed Image Data. Alberta Bureau of Surveys and Mapping, LRIS Newsletter, 6(2):5-8.

J.M. Mahoney, 1984. *An Evaluation of Shelterbelt Development in Alberta, (Summary Report)*. Alberta Environmental Research Trust. 41p.

M. McCallum, G. Browning, M. Dehn, J. Mahoney, K. Rothwell, U. Wittkugel & C. Yarmoloy, 1982. *Cutoff Creek Gas Pipeline Corridor Location Study*. Canterra Energy Ltd. 82p.

R. Bell, R. Coote, M. Copeman, T. Duguid, J. Mahoney, M. McCalum & B. Pitman, 1982. *Transportation Planning in Banff National Park: A response to Public Works Canada*. Faculty of Environmental Design, University of Calgary. 62p.

Conference Proceedings and Posters

A.R. Kalischuk, J.M. Mahoney & S.B. Rood, 1997. A Flood of Seedlings. *In*; Wetlands Heritage and Stewardship, Society of Wetland Scientists 18th Annual Meeting, Bozeman Montana.

J.M. Mahoney, 1997. Incorporating Downstream Ecosystem Concerns into reservoir Operations in Southwestern Alberta, Canada. *In*; Wetlands Heritage and Stewardship, Society of Wetland Scientists 18th Annual Meeting, Bozeman Montana.

A.R. Kalischuk, L.A. Gom, J.M. Mahoney & S.B. Rood, 1996. A River Ran Through It: Cottonwood seedling recruitment following the flood of the century in Chinook Country. Western Division, Canadian Association of Geographers Annual Meeting. March 8,9, Lethbridge, Alberta.

J.M. Mahoney, J. Willms & S.B. Rood, 1996. Environmental Control of Shoot Growth of Riparian Cottonwoods along the St. Mary River, Alberta, CANADA. *In*; Proceedings of the Fourth Prairie Conservation and Endangered Species Workshop, Lethbridge, February, 1995. Provincial Museum of Alberta, Curatorial Section, Edmonton. Natural History Occassional Paper No. 23.

S.B. Rood, J.M. Mahoney, K.P. Zanewich & M.F. Wilfong. 1996. River Damming and riparian Cottonwoods in the Western Prairies. *In*; Proceedings of the Fourth Prairie Conservation and Endangered Species Workshop, Lethbridge, February, 1995. Provincial Museum of Alberta, Curatorial Section, Edmonton. Natural History Occassional Paper No. 23.

J.M. Mahoney, J. Willms & S.B. Rood, 1994. Environmental Control of Branch and Annual Ring Growth in Riparian Poplars on the Lower St. Mary River, Alberta CANADA. *In*; Diverse Values: Seeking Common Ground, Northwest Regional Riparian Symposia. December 8-9, Boise Idaho.

J.M. Mahoney, 1993. A Model for Assessing the Effects of Altered River Flows on the Recruitment of Riparian Cottonwoods. *In*; Proceedings of the 30th Annual Department of Geography Conference. University of Calgary, Alberta. Awarded Prize for Best Paper at the Conference.

J.M. Mahoney & S.B. Rood, 1993. A model for assessing the Effects of Altered River flows on the Recruitment of Riparian Cottonwoods. *In*; Riparian Management: Common threads and shared interests, B. Tellman, H.J. Cortner, M.G. Wallace, L.F. DeBano & R.H. Hamre (eds). USDA Forest Service General Technical report RM-226, Albuquerque, NM.

S.B. Rood & J.M. Mahoney, 1993. River Damming and riparian Cottonwoods: Management opportunities and problems. *In*; Riparian Management: Common threads and shared interests, B. Tellman, H.J. Cortner, M.G. Wallace, L.F. DeBano & R.H. Hamre (eds). USDA Forest Service General Technical report RM-226, Albuquerque, NM.

S.B. Rood & J.M. Mahoney, 1992. Instream Flow Needs for Riparian Vegetation: Cottonwood forest ecosystems. *In*; Proceedings of the Instream Flow Needs Seminar, Alberta Environment, Agriculture, Forestry Lands and Wildlife, Water Resources Commision, Tourism Parks and recreation, Municipal Affairs, Edmonton.

J.M. Mahoney, P. Koegler & S.B. Rood, 1991. The Accuracy of Tree Ring Analysis for Estimating the Age of Riparian Poplars. *In*; Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference, S.B. Rood and J.M. Mahoney (eds). May 3,4, University of Lethbridge, Alberta.

K. Stobbs, A. Corbiere, J.M. Mahoney & S.B. Rood, 1991. The Influence of Rate of Water Table Decline on Establishment and Survival of Hybrid Poplar Seedlings. *In*; Proceedings of the Biology and Management of Southern Alberta's Cottonwoods Conference, S.B. Rood and J.M. Mahoney (eds). May 3,4, University of Lethbridge, Alberta.

S.B. Rood & J.M. Mahoney, 1990. The Collapse of River Valley Forests Downstream from dams in the Rocky Mountain Foothills. *In*; Collection Environnemment et Geologie, C.E. Delisle and A.M. Bouchard (eds). Canadian Society of Environmental biologists, Montreal. 9(21):417-430.

Invited Seminars and Conference Organization

Mahoney, J.M., 1998. Environmental Monitoring of the Oldman River Dam Project. Alberta Society of Professional Biologists, Professional Development Seminar, Calgary.

Mahoney, J.M., 1997. Incorporating Downstream Ecosystem Concerns into Reservoir Operations in Southwestern Alberta, Canada. Society of Wetland Scientists, Bozeman Montana.

Mahoney, J.M., 1996. The Oldman River Dam: Past, Present and Future Environmental Concerns. Department of Geography, University of Calgary.

Mahoney, J.M., 1993. River Hydrology and Riparian Cottonwoods. Biological Sciences, University of Lethbridge.

Co-organizer, 1990. Biology and Management of Southern Alberta Cottonwoods Conference. May 4-6, University of Lethbridge.

Mahoney, J.M., 1990. The Effects of Managing Water Resources on Riparian Poplars in Southern Alberta. Biological Sciences, University of Lethbridge.

Joe R. McBride
Department of Environmental Science, Policy, and Management
and
Department of Landscape Architecture
University of California, Berkeley, CA 94720

Education:

B.S. (Forestry) - University of Montana - 1960
M.S. (Forestry) - University of California, Berkeley - 1964
Ph.D. (Botany) - University of California, Berkeley - 1969

Employment:

Assistant Professor. Department of Forestry. Iowa State University. 1969-70.
Assistant Professor, Associate Professor, Professor. University of California. 1970-present.
Chair, Department of Forestry, University of California, 1986-89; Chair, Department of Environmental Science, Policy, and Management, University of California, 1996-98; Chair, Forest Science Division, University of California. 1996-present.

Teaching:

Courses in ecological analysis, forest ecology, vegetation management, urban forestry, regional landscape analysis, dendrology, and ecology of the Sierra Nevada

Research:

Studies concerned with urban forestry, the influence of land management on forest succession, regeneration and genetics of California oaks, riparian woodland ecology, and fire history.

Professional Experience:

Worked as a consultant in the fields of urban forestry, vegetation analysis, and management for over 25 years. Served as an advisor to federal, state, regional, county, and city governmental agencies. Registered professional forester in California (license #1306).

Professional Affiliations:

American Association for the Advancement of Science
American Society of Landscape Architects
California Botanical Society
Ecological Society of America
International Society for Landscape Ecology
Society of American Foresters
Society for Restoration Ecology

Awards:

Merit Award for Stanford University Vegetation Management Plan. ASLA. 1983
Resources Preservation Award for San Francisco Presidio Study. National Resources Council. 1987
Distinguished Teaching Award. University of California. 1991
Carl Alwin Schenck Award for Distinguished Teaching. Society of American Foresters. 1992
Honor Award for Sutro Baths Historic Restoration Plan. ASLA. 1993
Donald P. Gasser Award for Distinguished Contributions to Forestrty Education. University of California. 1997
Fellow Society of American Foresters. 1997

Publications:

Over 200 articles and research reports

Community Service:

Natural Heritage Advisory Committee, DFG, Sacramento, CA - 1980 to 1982
Blue Ribbon Fire Management Committee, EBRPD, Oakland, CA - 1982 to 1983
Task Force on Prescribed Burning in the National Parks, NPS - 1986 to 1987
Task Force on Biological Diversity, SAF, Washington, DC - 1987 to 1989
Natural Resource Advisor Amazanga Institute, Puyo, Equador - 1991-1994
Advisory Task Force on Vegetation Management in the National Parks of China, Chinese Academy of Forestry, Beijing - 1992-94
California Biodiversity Council, DFG, Sacramento, CA - 1996-97
Science Advisory Committee for the Southwestern Willow Flycatcher, USFWS and US Army Corps of Engineers, Sacramento, CA - 1997-98
Economic-Environmental Advisory Committee, Ningbo, P. R. China - 1997 -present

Joe R. McBride
Publications

Last Five Years:

Nowak, D.J. and J.R. McBride. 1992. Differences in Monterey pine pest populations in urban and natural forests. Forest Ecology and Management 50:133-144.

McCreary, S., G.M. Kondolf, J.R. McBride, and R. Twiss. 1992. Independent Review of Environmental Documentation for Petroleum Exploration in Block 10, Oriente, Ecuador. Center for Environmental Design Research. University of California. Berkeley, CA. 79 p.

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Selected Earlier Publications:

McBride, J.R. and H.F. Heady. 1968. Invasion of grassland by Baccharis pilularis, Jour. Range Mgt. 21:106-108.

McBride, J.R. 1974. Plant succession in the Berkeley Hills, California. Madrono 22:317-329.

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McBride, J.R. and D. Jacobs. 1976. Urban forest development: A study, Menlo Park, California. Urban Ecology 2:1-14.

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Jacobs, D., D. Cole and J.R. McBride. 1985. Fire history and the perpetuation of natural coast redwood ecosystems. Jour. Forestry 83:494-497.

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Nowak, O.J., McBride, R. and R.A. Beatty. 1990. Newly planted street tree growth and mortality. J. Arboriculture 16(5): 124-129.

Nowak, D.J. and J.R. McBride. 1991. Comparisons of Monterey pine stress in urban and natural stands. Jour. Environ. Management. 32:383-395.

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Education

Ph.D.,University of Washington, 1982
M.S., *University of Washington*, 1975
B.S., Occidental College, 1972

Honors

National Science Foundation, Presidential Young Investigator, 1985-1990
Gordon Warwick Award, British Geomorphological Research Group, 1986
Fellow, American Geophysical Union, 1992
Fellow, Geological Society of America, 1992
Wiley Award for paper published in Earth Surface Processes and Landforms in 1991 (with Steve Reneau) (given by the British Geomorphological Research Group)
Crosby Lecturer, MIT, 1994
Horton Award, American Geophysical Union, 1995

Professional Experience

Summer intern, Water Resources Technical Division, Washington, State Department of Ecology, 1974
Research Assistant, University of Washington, 1978-1981
Assistant Professor, University of California, Berkeley, 1981-1986
Associate Professor, University of California, Berkeley, 1986- 1990
Occasional consultant on hydrology, fluvial and hillslope geomorphology

Professional Societies

American Geophysical Union
British Geomorphological Research Group
Japanese Geomorphological Union
Geological Society of America
American Geomorphological Field Group

Professional Responsibilities

Member, American Geophysical Union Hydrology Section Unsaturated Zone Committee, 1984-1992 and Erosion and Sedimentation Committee, 1984-present
Chairman, Erosion and Sedimentation Committee of the American Geophysical Union Hydrology Section, 1988-1990
Member, Editorial Board, *Geology*, 1986-1988; 1990-1993
Member, National Science Foundation sponsored Japan-U.S. Cooperative Science Program on Mechanics of River Meanders, 1985-1987
Member, the Commission on Measurement, Theory and Application in Geomorphology, International Geographical Union, 1984-1988
Member, the Erosion Studies Scientific Advisory Committee of the California Department of Forestry and Fire Protection, 1986
Member, Editorial Board, *Catena*, 1986-1992
Editorial Board, Annual Reviews of Earth and Planetary Sciences 1992-1996
Deputy Editor, Water Resources Research, 1993-1996

Academic Responsibilities

Graduate Advisor, 1982-1985; 1990-1992
Undergraduate Advisor, 1986-1988; 1989-1990
Member of Group in Soil Science, 1983-1991
Affiliated Faculty of Energy and Resources Group, 1989-present

Publications

1. Dietrich, W.E., 1975, Surface water resources of San Juan County, *in*, Geology and Water Resources of the San Juans, R.H. Russel (ed.), Water Supply Bulletin No. 46, Washington Department of Ecology, p. 59-125.

2. Dietrich, W.E. and T. Dunne, 1978, Sediment budget for a small catchment in mountainous terrain: Zeit. für Geomorph., Suppl. Bd. 29, p. 191-206.

3. Dunne, T., W.E. Dietrich and M. Brunengo, 1978, Recent and past erosion rates in semi-arid Kenya: Zeit. für Geomorph., Suppl. Bd. 29, p. 130-140.

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9. Dunne, T., W.E. Dietrich, N. Humphrey and D. Tubbs, 1981, Geologic and geomorphic aspects of gravel supply in western Washington, *in*, Proc. on Salmon-spawning Gravels, J.J. Cassidy (ed.), Wash. State Water Res. Center, Report No. 39, p. 75-100.

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11. Dunne, T. and W.E. Dietrich, 1982, Sediment sources in tropical catchments: Proc. Soil Erosion and Conservation in the Tropics, Amer. Soc. of Agronomy Symp., Colorado State University, August 1979, Spec. Publ., no. 43, p. 41-55.

12. Dietrich, W.E., 1982, Settling velocity of natural particles: Water Resources Research, v. 18, no. 6, p. 1615-1626.

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66. Dietrich, W.E., Reiss, R., Hsu, M., and Montgomery, D.R., 1995, A process-based model for colluvial soil depth and shallow landsliding using digital elevation data, Hydrological Processes, Vol. 9, 383-400.

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"The grazing ecology of armored catfish in a Panamanian stream"

Professional Experience

Visiting Assistant Professor, Division of Entomology and Parasitology, University of California, Berkeley, 1986-1987
Assistant Professor, Department of Zoology, and Integrative Biology, University of California, Berkeley, 1987-1992
Associate Professor, Department of Integrative Biology, University of California, Berkeley, 1992 - 1996
Professor, Department of Integrative Biology, University of California, Berkeley, 1996 - present

Faculty Manager, Angelo Coast Range Reserve, 1989 - present
Chair, Aquatic Ecology Section, Ecological Society of America, 1995-1996
Chair, University-Wide Natural Reserve System Advisory Committee, 1995-1998

Honors and Awards

Sigma Xi, 1971

Phi Beta Kappa, 1971

B.A., magna cum laude 1971

Summer student fellowships, Woods Hole Oceanographic Inst., 1972, 1973

Nobel summer fellowship, Smithsonian Tropical Res. Inst., 1976

Walter Rathbone Bacon Fellowship for Field Biology, Smithsonian Institution, 1978-80

National Science Foundation Dissertation Improvement award 1978-80 ($3300)

National Science Foundation award (Ecology panel), 1983-85: "Multi-level effects of an algae-grazing minnow (Campostoma anomalum) on north temperate streams (with Drs. W.J. Matthews and A.J. Stewart, Univ. Oklahoma ($60,000)

National Science Foundation supplementary award (Ecology panel), 1983-85: "Predators and algae-grazing minnows in north temperate streams: Does the kind of predator matter?" (with Drs. Matthews, Stewart, and R. Cashner) ($10,848)

Jasper Loftus-Hills Prize for Young Investigators, from the American Society of Naturalists, 1985

National Science Foundation Visiting Professorship for Women, 1986-1988: "The role of primary consumers in structuring communities of northern Californian streams ($145,265)

Junior Faculty Award, University of California, Berkeley, 1988

Water Resources Center (California) Award: 1988-90: "Seasonal and hydrologic controls of algal blooms in northern California rivers." ($52,600)

National Science Foundation award (Ecology panel), 1991-1993: "Productivity, plant biomass, and trophic interactions in rivers." ($192,097)

National Science Foundation award (Conservation Biology panel), 1991-1993: "Food web analysis of biodiversity: Application to algal-based river systems." ($100,000)

National Science Foundation award (Ecology panel) (1994-1996): "Disturbance and the structure of river food webs" (with J.T. Wootton and M.S. Parker, $300,000)

Water Resources Center (California) Award: 1993-1995. Effects of stream flow regulation and reduction of scouring floods on trophic transfer of biomass to fish in northern California rivers. ($37,220)

Fulbright Scholar 1994-1995

Teaching Interests

Community ecology, grazing, fish biology, freshwater ecology, food webs

Publications

Power, M.E. 1997. Estimating impacts of a dominant detritivore in a neotropical stream. Review for Trends in Ecology and Systematics 12: 47-49.

Wootton, J.T., M.E. Power, R.T. Paine and C. Pfister. 1997. Nutrients, El Nino Events, and Food Chain Processes in the Rocky Intertidal. Proc. National Academy of Sciences, in press.

Power, M.E., S.J. Kupferberg, G.W. Minshall, M.C. Molles and M.S. Parker. 1997. Sustaining Western Aquatic Food Webs. pp. 45-61 inW.C. Minckley (ed.) Aquatic Ecosystems Symposium, Tempe AZ. Report to the Western Water Policy Review Presidential Advisory Commission.

Power, M.E., W.E. Dietrich, and K.O. Sullivan. Experiment, observation, and inference in river and watershed investigations. *In W.J. Resetarits and J. Bernardo, eds. Issues and perspectives in experimental ecology.* Oxford Univ. Press, Oxford, UK, in press.

Carpenter, S., T. Frost, L. Persson, M. Power and D. Soto. 1996. Freshwater ecosystems: Linkages of complexity and processes. pp. 299-325 in Mooney, H.A., Cushman, J.H., Sala O.E. and Schulze, E-D. (eds.) Funcitonal Roles of Biodiversity: A Global Perspective. Wiley, N.Y.

Power, M.E., W.E. Dietrich, and J.C. Finlay. 1996. Dams and downstream aquatic biodiversity: Potential food web consequences of hydrologic and geomorphic change. Environmental Management 20: 887-895.

Power, M.E., D. Tilman, J. A. Estes, B.A. Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco, and R.T. Paine. 1996. Challenges in the quest for keystones. BioScience 46: 609-620.

Wootton, J.T., M.S. Parker and M.E. Power. 1996. The effect of disturbance on river food webs. Science 273: 1558-1560.

Power, M.E., A. Sun, G. Parker, W.E. Dietrich and J.T. Wootton. 1995. Hydraulic food chain models. BioScience 45: 159-167

Power, M.E. 1995. Floods, food chains and ecosystem processes in rivers. pp. 52-60 in: C.L. Jones and J.H. Lawton (eds.) Linking Species and Ecosystems. Chapman and Hall, N.Y.

Power, M.E. G. Parker, W.E. Dietrich, and A. Sun. 1995. How does floodplain width affect floodplain river ecology? An preliminary exploration using simulations. Geomorphology 13: 301-317.

Oksanen, T., M.E. Power and L. Oksanen. 1995. Habitat selection and consumer resources. American Naturalist 146: 565-583.

Power, M.E., M.S. Parker and J.T. Wootton. 1995. Disturbance and food chain length in rivers. pp. 286-297 in G.A. Polis and K.O. Winemiller (eds.) Food Webs: Integration of Patterns and Dynamics. Chapman and Hall, N.Y.

Persson, L., J. Bengtsson, B.A. Menge and M.E. Power. 1995. Productivity and the structure and regulation of communities. pp. 396-434 in G.A. Polis and K.O. Winemiller (eds.) Food Webs: Integration of Patterns and Dynamics. Chapman and Hall, N.Y.

Power, M.E. and L. S. Mills. 1995. The Keystone Cops meet in Hilo. Trends in Evolution and Ecology 10: 182-184 (not peer reviewed)

Carpenter, S., T. Frost, L. Persson, M. Power, and D. Soto. 1995. Lakes and rivers. pp. 157-164 In H.A. Mooney and J. Lubchenco. *SCOPE Global Biodiversity Assessment, UNEP. (not peer reviewed).*

Kupferberg, S.J., J.C. Marks and M.E. Power. 1994. Effects of variation in natural algal and detrital diets on larval anuran (Hyla regilla) life history traits. Copeia 1994 (2): 446-457.

Matthews, W.J., B.C. Harvey and M.E. Power. 1994. Spatial and temporal patterns in the fish assemblages of individual pools in a midwestern stream (USA). Environmental Biology of Fishes 39: 381-397.

Wootton, J.T. and M.E. Power. 1993. Productivity, consumers, and the structure of a river food chain. Proc. Nat. Acad. Sci. USA 90: 1384-1387.

Power, M. E. 1992. Habitat heterogeneity and the functional significance of fish in river food webs. Ecology 73: 1675-1688.

Power, M. E. 1992. Top down and bottom up forces in food webs: do plants have primacy? Ecology 73: 733-746.

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Power, M.E., A.J. Stewart and W.J. Matthews. 1988. Grazer control of attached algae in an Ozark Mountain stream: Effects of short-term exclusion. Ecology 69: 1894-1989.

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Power, M.E. 1984. Depth distributions of armored catfish: Predator-induced resource avoidance? Ecology 65: 523-528.

Power, M.E. 1984. Habitat quality and the distribution of algae-grazing catfish in a Panamanian stream. J. Anim. Ecol. 53: 357-374.

Power, M.E. 1984. The importance of sediment in the feeding ecology and social interactions of an armored catfish, Ancistrus spinosus. Environ. Biol. Fish. 10: 173-181.

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Curriculum Vitae

Terence Paul Speed
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Australian citizen; US Permanent Resident
Date of Birth: March 14, 1943
Education: BSc(Hons) Melbourne 1965, PhD DipEd Monash 1969

Appointments:

1965-69 Tutor, Senior Tutor and Lecturer
Department of Mathematics, Monash University

1969-73 Lecturer, Department of Probability and
Statistics, University of Sheffield

1974-75 Associate Professor, Department of Mathematics
University of Western Australia

1975-82 Professor, Department of Mathematics
University of Western Australia
(Head of Department 1980-82)

1983-87 Chief, Division of Mathematics and Statistics
Commonwealth Scientific and Industrial Research
Organization (Australia)

1987- Professor, Department of Statistics,
University of California, Berkeley
(Chair, 1989-93)

1996- Adjunct Professor, School of Mathematical Sciences,
Australian National University

Membership of Professional Bodies:

Australian Mathematical Society
Statistical Society of Australia
Royal Statistical Society
American Statistical Association (Fellow)
Institute of Mathematical Statistics (Fellow)
Biometric Society
International Statistical Institute (Member)
Genetics Society of America
American Society of Human Genetics
Society of Molecular Biology and Evolution
American Association for the Advancement of Science (Fellow)

Current/Previous Memberships:

Australian Statistics Advisory Council (1983-87)
Board of Management, Australian Institute of Criminology (1983-87)
Board of Directors, SIROMATH Pty Ltd (1983-87)
Genome Study Section, National Institutes of Health (1995-1998)

Recent offices held in professional bodies:

Western Northern American Region of Biometrics Society President-Elect (1991-92); President (1992-3); Past President (1993-4)
Institute of Mathematical Statistics: Council Member (1993-1996)

Editorial responsibilities:

Associate Editor: Annals of Statistics (1986-1992); Journal of the American Statistical Association (1988- 1992); International Statistical Review (1987-1991); Journal of Statistical Planning and Inference (1989- 1992); Statistical Science (1991-1994); Journal of Computational Biology (1993-present).

Bibliography

Terence Paul Speed

Publications:

[1] "On rings of sets", *J. Aust. Math. Soc.* **8** (1968), 723-730.

[2] "A note on commutative semigroups", *J. Aust Math. Soc.* **8** (1968) 731-736.

[3] "Some remarks on a class of distributive lattices", *J. Aust. Math. Soc.* **9** (1969) 289-296.

[4] "On Stone lattices", *J. Aust. Math. Soc.* **9** (1969) 297-307.

[5] "Spaces of ideals of distributive lattices I. Prime ideals", *Bull. Soc. Roy. de Liege* No. 11-12, (1969) 610-628.

[6] "Two congruences on distributive lattices", *Bull. Soc. Roy. de Liege* No. 3-4, (1969) 86-95.

[7] "A note on commutative semigroups II", *J. Lond. Math. Soc.* (2), 2 (1970) 80-82.

[8] "A note on commutative l-groups" (with E. Strzelecki). *J. Aust. Math. Soc.* **12** (1971) 69-74.

[9] "A note on random walks" (with R.M. Phatarfod and A.M. Walker). *J. Appl. Prob.* **8** (1971) 198-201.

[10] "A note on Stone lattices", *Cand. Math. Bull.* Vol. 14 (1) (1971) 81-86.

[11] "A note on commutative Baer rings" (with M.W. Evans). *J. Aust. Math. Soc.* **13** (1971) 1-6.

[12] "A note on Post algebras", *Colloq. Math.* **14** (1971) 37-44.

[13] "Profinite posets", *Bull. Aust. Math. Soc.* **6** (1972) 257-263.

[14] "A note on commutative Baer rings", *J. Aust. Math. Soc.* **14** (1972) 257-263.

[15] "On the order of prime ideals", *Alg. Univ.* **2** (1972) 85-87.

[16] "A note on random walks, II", *J. Appl. Prob.* **10** (1973) 218-222.

[17] "Some remarks on a result of Blomqvist", *J. Appl. Prob.* **10** (1973) 229-232.

[18] "A note on commutative Baer rings, III", *J. Aust. Math. Soc.* **15** (1973) 5-21.

[20] "A note on the second factorisation identity of A.A. Borovkov" (with E. Arjas) *Teor. Verojatnost. i. Primenen.* **18** (1973) 601-604.

[21] "An extension of Cramér's estimate for the absorption probability of a random walk", *Proc. Camb. Phil. Soc.* **73** (1973) 355-359.

[22] "Topics in Markov additive processes" (with E. Arjas). *Math. Scand.* **33** (1973) 171-192.

[23] "Symmetric Wiener-Hopf factorisations in Markov additive processes" (with E. Arjas). *Z. Warscheinlichkeitstheorie und Verw. Geb.* **26** (1973) 105-118.

[24] "A stopping problem in Markov additive processes" (with E. Arjas). Abstract of a paper presented to the Second Conference on Stochastic Processes and their Applications. *Adv. in Appl. Prob.* **5** (1973) 2-3.

[25] "A note on random times" (with J.W. Pitman). *Stoch. Proc. Appl.* **1** (1973) 369-374.

[26] "Spaces of ideals of distributive lattices, II. Minimal prime ideals", *J. Aust. Math. Soc.* **18** (1974) 54-72.

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[28] "Cytological changes in the conjunctiva in the megaloblastic anemias" (with J.D. Brodrick and I.M. Strachan). *Investigative Opthalmology* **13** (1974) 870-872.

[29] "Statistics in school and society", *Mathematical Spectrum* **6** (1974) 7-11.

[30] "Markov chains with replacement" (with E. Arjas), extract from *Adv. Appl. Prob.* **6** (1974) 188-259. Abstract.

[31] "Markov chains with replacement" (with E. Arjas). *Stoch. Proc. Appl.* **3** (1975) 175-184.

[32] "Geometric and probabilistic aspects of some combinatorial identities", *J. Aust. Math. Soc.* **22** (1976) 462-468.

[33] "A note on pairwise sufficiency and completions", *Sankhya Ser. A.* **38** (1976) 194-196.

[34] "Lagrangian distributions and their limit theorems" (with A.G. Pakes). *Siam J. Appl. Math.* **32** (1977) 45-754.

[35] "Electrostatic energy of disordered distributions of vacancies for altervalent ions" (with W.W. Barker, J. Graham and T.C. Parks). *J. Solid State Chem.* **22** (1977) 321-329.

[36] "A factorisation theorem for adequate statistics", *Aust. J. Stat.* **20** (1978) 240-249.

[37] "Intestinal transport of monosaccharide after biliary diversion in the rat" (with Valerie Burke, Ann Malajczuk, M. Gracey, and M.L. Thornett). *Aust. J. Exp. Biol. Med. Sci.* **56** (1978) 253-263.

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[40] "Multiplicative and additive models for interaction" (with J.N. Darroch). Research Report, Institute of Statistics, Aarhus University. (1979).

[41] "Forsvindende sandsynlicheder og atomkraftsikkerhed: et nyt misbrug af sandsynlighedsregningen?" *RAMA* **1** (1979) 1-33.

[42] "A note on nearest-neighbour Gibbs and Markov probabilities", *Sankhya Ser. A* **41** (1979) 184-197.

[43] "Markov fields and log-linear interaction models for contingency tables" (with J.N. Darroch and S.L. Lauritzen). *Ann. Stat.* **8** (1980) 522-539.

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[46] "The structural analysis of multivariate data: a review" (with H. Kiiveri). *Sociological Methodology* edited by Samuel Leinhardt. Ch.6, 209-290. Jossey-Bass, San Francisco (1982).

[47] "On a class of association schemes derived from lattices of equivalence relations" (with R.A. Bailey). *Algebraic Structures and their Applications* edited by Philip Schultz, Cheryl E. Praeger, and Robert P. Sullivan. Marcel Dekker, New York (1982).

[48] "A study of isolation procedures for multiple infections of Salmonella and Arizona in a wild marsupial, the quokka (Setonix brachyurus)", (with R.P. Hart, J.B. Iveson, and S.D. Bradshaw). *J. Appl. Bacteriology* **53** (1982) 395-406.

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[53] "Additive and multiplicative models and interactions" (with J.N. Darroch). *Ann. Statist.* **11** (1983) 724-738.

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[88] Incorporating prior information into the analysis of contingency tables (with M.W. Knuiman). *Biometrics*, **44** (1988) 1061-1071.

[89] On the existence of maximum likelihood estimators for hierarchical loglinear models (with G.F.V. Glonek and J.N. Darroch). *Scand. J. Statist.*, **15** (1988) 187-193.

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[92] On a matrix identity associated with generalized least squares (with F.R. de Hoog and E.R. Williams) *Linear Algebra Applic.*, **127** (1990) 449-456.

[93] Inner cell allocation in the mouse morula: the role of oriented division during fourth cleavage (with A. Sutherland and P. Calarco) *Developmental Biology*, **137** (1990) 13-25.

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[130] Summarizing and combining gene maps (with S Lin). *Annals of Human Genetics.* (1996) **60** 251-257.

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[134] The effects of genotyping errors and interference on estimation of genetic distance (with D R Goldstein and H Zhao) *Human Heredity*

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Manuscripts Submitted

1. Comparing DNA-DNA hybridization curves by rates of decay (with R. Guerra) Molecular Biology and Evolution.
2. A decision problem in physical mapping (with B. Yu and D.O. Nelson)
3. Modelling crossover interference using the Poisson skip model (with H. Zhao and K Lange).
4. An algorithm for haplotype analysis (with Shili Lin).

APPENDIX E

STATE OF CALIFORNIA

NONDISCRIMINATION COMPLIANCE STATEMENT

STD. 19 (REV. 3-95) FMC

COMPANY NAME
Stillwater Ecosystem, Watershed, & Riverine Sciences

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME
Christine Champe

DATE EXECUTED	EXECUTED IN THE COUNTY OF
15 April 1999	Alameda

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE
President / CEO

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME
Stillwater Ecosystem, Watershed, & Riverine Sciences

U.S. Department of the Interior

Certifications Regarding Debarment, Suspension and Other Responsibility Matters, Drug-Free Workplace Requirements and Lobbying

Persons signing this form should refer to the regulations referenced below for complete instructions:

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions - **The prospective primary participant further agrees by submitting this proposal that it will include the clause titled, "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.** See below for language to be used; use this form for certification and sign; or use Department of the Interior Form 1954 (DI-1954). (See Appendix A of Subpart D of 43 CFR Part 12.)

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions - (See Appendix B of Subpart D of 43 CFR Part 12.)

Certification Regarding Drug-Free Workplace Requirements - Alternate I. (Grantees Other Than Individuals) and Alternate II. (Grantees Who are Individuals) - (See Appendix C of Subpart D of 43 CFR Part 12)

Signature on this form provides for compliance with certification requirements under 43 CFR Parts 12 and 18. The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of the Interior determines to award the covered transaction, grant, cooperative agreement or loan.

PART A: Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions

---

CHECK ✓ IF THIS CERTIFICATION IS FOR A PRIMARY COVERED TRANSACTION AND IS APPLICABLE.

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

PART B: Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions

---

CHECK__ IF THIS CERTIFICATION IS FOR A LOWER TIER COVERED TRANSACTION AND IS APPLICABLE

(1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

DI-2010
March 1995
(This form consolidates DI-1953, DI-1954, DI-1955, DI-1958 and DI-1963)

PART C: Certification Regarding Drug-Free Workplace Requirements

CHECK ✓ IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS NOT AN INDIVIDUAL.

Alternate I. (Grantees Other Than Individuals)

A. The grantee certifies that it will or continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about--
(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs; and
(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --
(1) Abide by the terms of the statement; and
(2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

(e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification numbers(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted --
(1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a) (b), (c), (d), (e) and (f).

B. The grantee may insert in the space provided below the site(s for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

2532 Durant Ave., Suite 201

Berkeley, CA 94704

Check___if there are workplaces on file that are not identified here.

PART D: Certification Regarding Drug-Free Workplace Requirements

CHECK__IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS AN INDIVIDUAL.

Alternate II. (Grantees Who Are Individuals)

(a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;

(b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant

PART E: Certification Regarding Lobbying
Certification for Contracts, Grants, Loans, and Cooperative Agreements

CHECK ✓ IF CERTIFICATION IS FOR THE AWARD OF ANY OF THE FOLLOWING AND THE AMOUNT EXCEEDS $100,000: A FEDERAL GRANT OR COOPERATIVE AGREEMENT; SUBCONTRACT, OR SUBGRANT UNDER THE GRANT OR COOPERATIVE AGREEMENT.

CHECK __ IF CERTIFICATION IS FOR THE AWARD OF A FEDERAL LOAN EXCEEDING THE AMOUNT OF $150,000, OR A SUBGRANT OR SUBCONTRACT EXCEEDING $100,000, UNDER THE LOAN.

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

As the authorized certifying official, I hereby certify that the above specified certifications are true.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL Christine Champe

TYPED NAME AND TITLE Christine Champe Principal & Vice-President

DATE 15 April 99

APPLICATION FOR FEDERAL ASSISTANCE

OMB Approval No. 0348-0043

2. DATE SUBMITTED	Applicant Identifier
16 April 1999	N/A
3. DATE RECEIVED BY STATE	State Application Identifier
4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

1. TYPE OF SUBMISSION:

Application: ☐ Construction ☒ Non-Construction

Preapplication: ☐ Construction ☐ Non-Construction

5. APPLICANT INFORMATION

Legal Name: Stillwater Ecosystem, watershed, & Riverine Sciences

Organizational Unit: N/A

Address *(give city, county, State, and zip code)*: 2532 Durant Ave., Suite 201, Berkeley, CA 94704, Alameda County

Name and telephone number of person to be contacted on matters involving this application *(give area code)*: John Stella (510) 848-8098

6. EMPLOYER IDENTIFICATION NUMBER *(EIN)*: 94-3241861

7. TYPE OF APPLICANT: *(enter appropriate letter in box)* M

A. State; B. County; C. Municipal; D. Township; E. Interstate; F. Intermunicipal; G. Special District; H. Independent School Dist.; I. State Controlled Institution of Higher Learning; J. Private University; K. Indian Tribe; L. Individual; M. Profit Organization; N. Other (Specify) _____

8. TYPE OF APPLICATION:

☒ New ☐ Continuation ☐ Revision

If Revision, enter appropriate letter(s) in box(es) ☐ ☐

A. Increase Award; B. Decrease Award; C. Increase Duration; D. Decrease Duration; Other *(specify)*: _____

9. NAME OF FEDERAL AGENCY: Bureau of Reclamation, Department of the Interior

10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: N/A

TITLE:

11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin

12. AREAS AFFECTED BY PROJECT *(Cities, Counties, States, etc.)*: Stanislaus and Merced Counties

13. PROPOSED PROJECT		14. CONGRESSIONAL DISTRICTS OF:	
Start Date	Ending Date	a. Applicant	b. Project
9/1/99	8/31/01	#9	#18

15. ESTIMATED FUNDING:

a. Federal	$ 223,666.00
b. Applicant	$ —.00
c. State	$ —.00
d. Local	$ —.00
e. Other	$ —.00
f. Program Income	$ —.00
g. TOTAL	$ 223,666.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS? N/A

a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:

DATE _____

b. No. ☐ PROGRAM IS NOT COVERED BY E. O. 12372
☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

☐ Yes If "Yes," attach an explanation. ☒ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT, THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Type Name of Authorized Representative	b. Title	c. Telephone Number
Christine Champe	Principal & Vice President	(510) 848-8098
d. Signature of Authorized Representative		**e. Date Signed**
Christine Champe		15 April 99

Previous Edition Usable

Authorized for Local Reproduction

Standard Form 424 (Rev. 7-97)

Prescribed by OMB Circular A-102

OMB Approval No. 0348-0044

BUDGET INFORMATION - Non-Construction Programs

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin	—	$ —	$ —	$ 223,666	$ —	$ 223,666
2. —	—	—	—	—	—	—
3. —	—	—	—	—	—	—
4. —	—	—	—	—	—	—
5. Totals	—	$ —	$ —	$ 223,666	$ —	$ 223,666

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1) Riparian Restoratio	(2)	(3)	(4)	Total (5)
a. Personnel	$ 62,606	$ —	$ —	$ —	$ 62,606
b. Fringe Benefits	13,643	—	—	—	13,643
c. Travel	5,000	—	—	—	5,000
d. Equipment	16,000	—	—	—	16,000
e. Supplies	8,979	—	—	—	8,979
f. Contractual	6,000	—	—	—	6,000
g. Construction	—	—	—	—	—
h. Other	—	—	—	—	—
i. Total Direct Charges (sum of 6a-6h)	112,228	—	—	—	112,228
j. Indirect Charges	111,438	—	—	—	111,438
k. TOTALS (sum of 6i and 6j)	$ 223,666	$ —	$ —	$ —	$ 223,666
7. Program Income	$ —	$ —	$ —	$ —	$ —

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS
8. —	$ —	$ —	$ —	$ —
9. —	—	—	—	—
10. —	—	—	—	—
11. —	—	—	—	—
12. TOTAL (sum of lines 8 - 11)	$ —	$ —	$ —	$ —

SECTION D - FORCASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 146,307	$ 7,227	$ 47,423	$ 47,157	$ 44,500
14. NonFederal	—	—	—	—	—
15. TOTAL (sum of lines 13 and 14)	146,307	7,227	47,423	47,157	44,500

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (Years) (b) First	(c) Second	(d) Third	(e) Fourth
16. —	$ —	$ —	$ —	$ —
17. —	—	—	—	—
18. —	—	—	—	—
19. —	—	—	—	—
20. TOTAL (sum of lines 16-19) —	$ —	$ —	$ —	$ —

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: —

22. Indirect Charges: Overhead and profit are calculated as 1.78 × personnel costs

23. Remarks: —

OMB Approval No. 0348-0040

ASSURANCES - NON-CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Christine Champe	Principal and Vice President
APPLICANT ORGANIZATION	DATE SUBMITTED
Stillwater Ecosystem, Watershed, & Riverine Sciences	16 April 1999